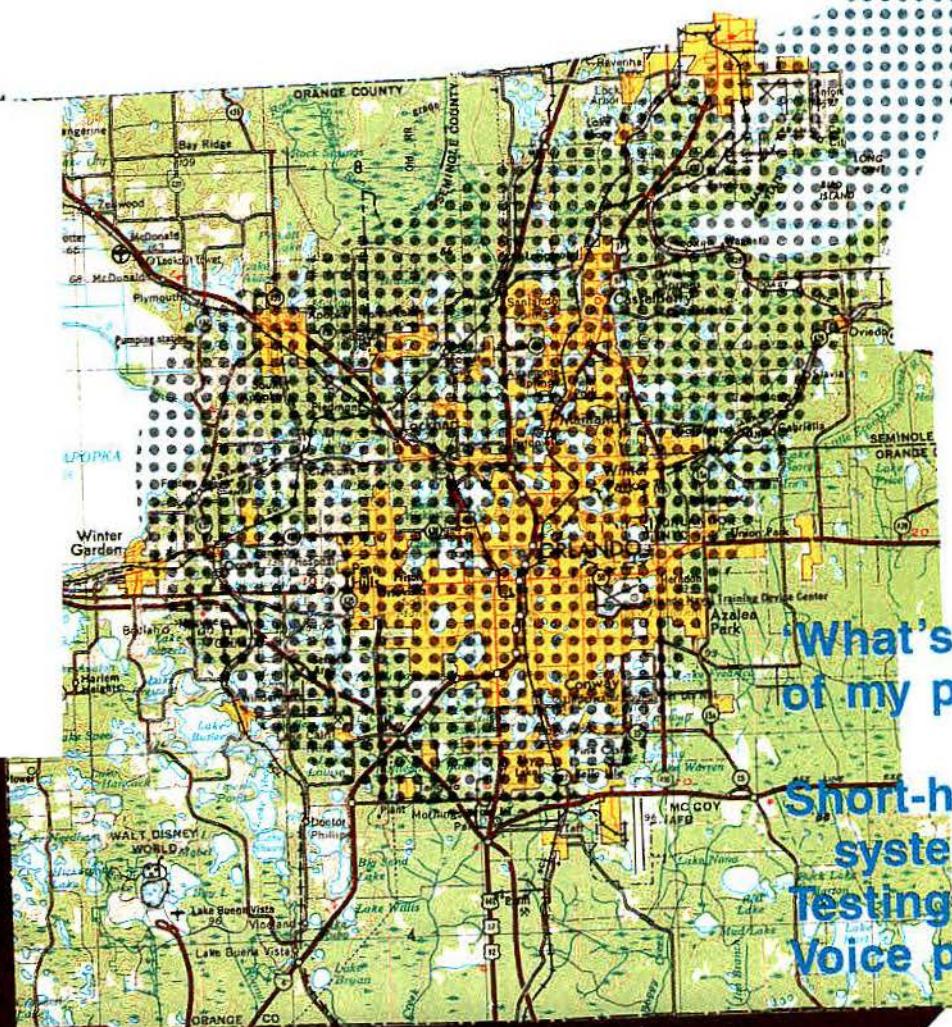


May 1989/\$2.00

Mobile Radio Technology

The journal of mobile communications technology



‘What’s the range of my pager?’ p. 10

Short-haul microwave systems

Testing remote controls Voice paging network

Voice paging network

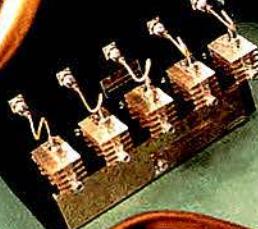


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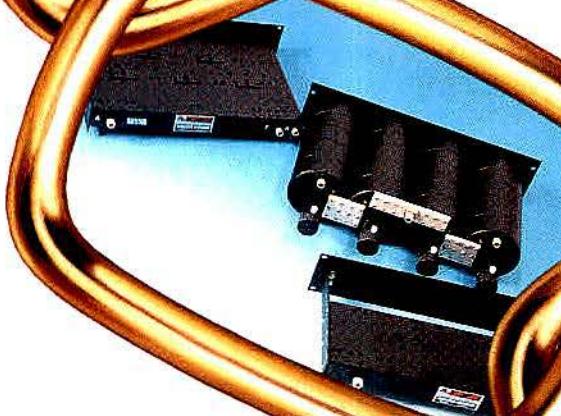
RF site products, for example:

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features —

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Jim Hathaway and Roy Holmes, Reach Electronics
Systems equipment buyers want to know. Here's how to answer.

24 Use short-haul microwave in land mobile systems

Jim Screeeden and Dave Babbit, Motorola
Relay links bring critical network connections under the system operator's control.

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Don Arnold, Commonwealth Communications Industries
Telocator's network paging protocol makes voice networks practical.

44 Base remote control performance testing

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Records you create will help in future troubleshooting.

81 Product Preview

Use this section as a "mini-catalog" of land mobile products and services.

On the cover: Pagers do not have "range"; paging systems do. But customers still ask, "What's the range of my pager?" The answer is on page 10.

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Now can we have our public safety frequencies?

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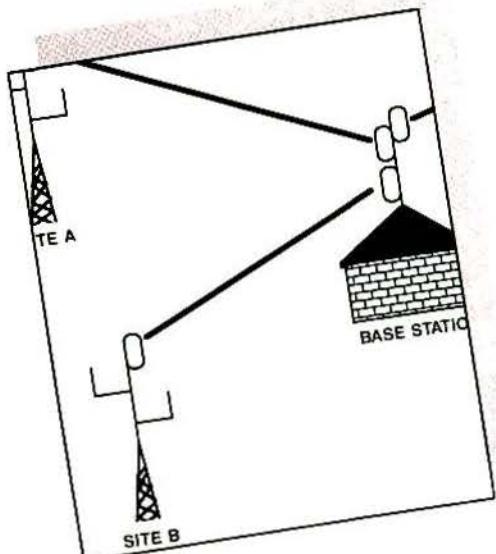
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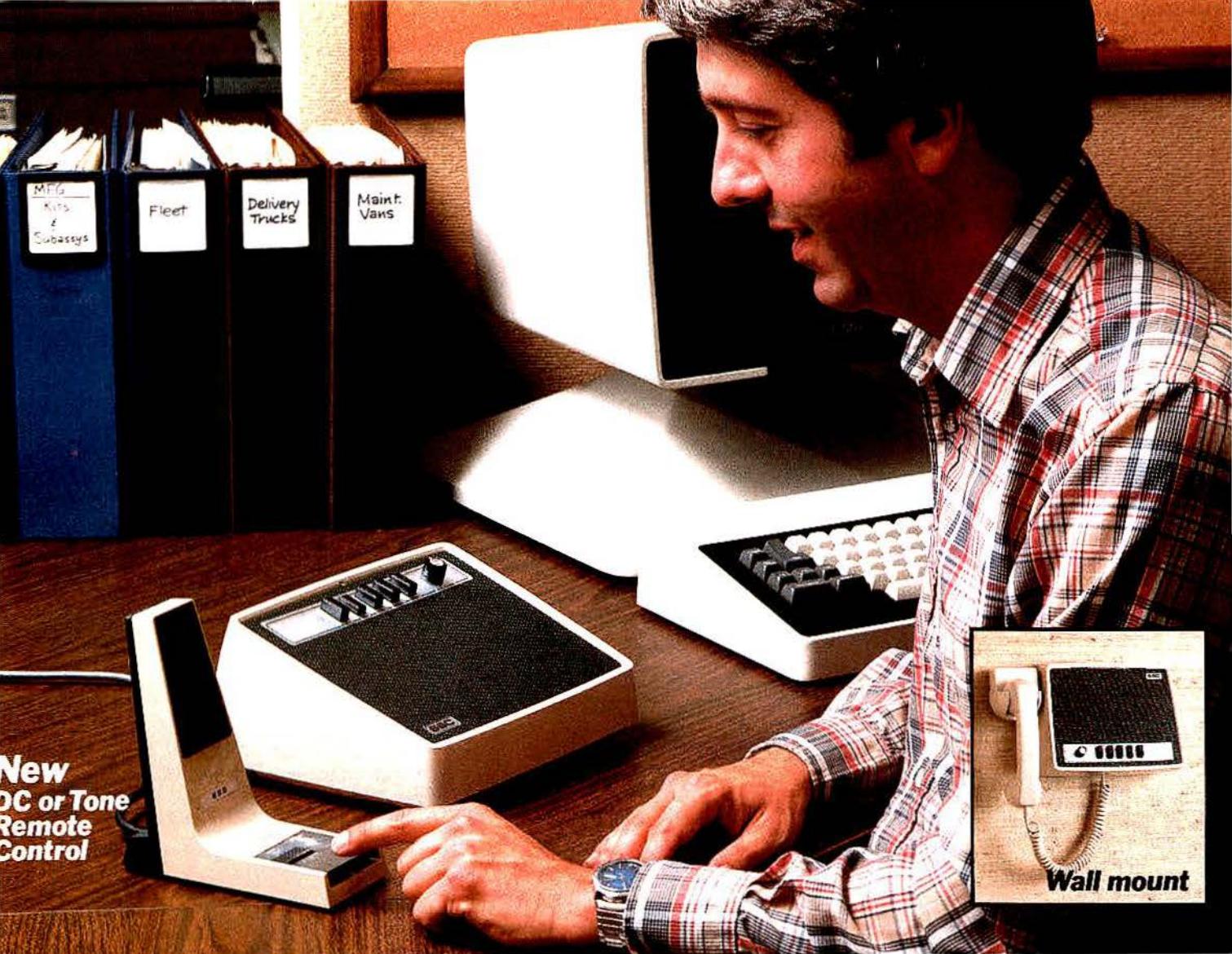
Do you favor flexible use of spectrum?



page 24



page 44



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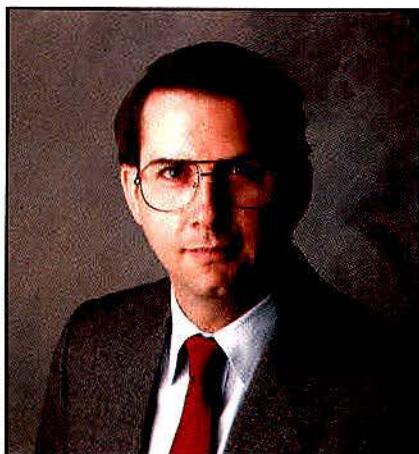
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Binary coding, commonly known as "digital," is expanding its dominance over continuous-signal analog modulation:

- Cellular mobile telephone common carriers have selected digital for the next generation of cellular mobile telephone equipment.
- Wireline telephone common carriers are developing an integrated services digital network (ISDN).
- The FCC decided on Feb. 22 not to adopt trunking compatibility standards for the 800MHz public safety bands in part because of expected developments in digital technology. The FCC concluded:

(1) Federally mandated uniform trunking standards for analog public safety communications are not necessary to achieve adequate interoperability among 800MHz public safety agencies.

(2) Any action by the government to direct the industry to develop an analog trunking standard would be inappropriate because such action could force manufacturers to divert research funds away from the development of new, more spectrally efficient call-handling technologies.

(3) The public interest would be served best by the expeditious licensing of public safety communications systems, upon approval of the relevant regional plans.

"Concerns regarding interoperability, as well as maximizing the efficient use of the public safety spectrum, will best be resolved through the development of digital or other future advanced communications systems, not further refinement of existing technologies," an FCC

document reads. What's next?

A *Further Notice of Inquiry* to consider trunking standards.

The next inquiry will "consider various issues relating to the FCC's role in promoting the development of advanced public safety communications technologies," the document reads.

Commissioner James H. Quello wrote: "I am pleased to see that we are addressing the issue of standards in the next generation of technology by issuing a *Further Notice of Inquiry*. In fact, I would prefer establishing an advisory committee to seek its recommendation for a minimum digital standard for public safety services and potential implementation schedule."

Quello earlier proposed to withhold

his vote in FCC proceedings to approve regional plans, and thus licenses, until the agency deliberated whether to establish a trunking standard. Only three commissioners occupy seats at the commission, which is authorized for five. Quello is in a position to block the issuance of licenses for the new 800MHz public safety band because without his participation, the commission lacks a quorum.

Compromise is at work. In this latest FCC action, the way is cleared for public safety agencies in the largest cities to receive licenses for urgently needed spectrum. Quello receives a commitment that trunking standards will be deliberated anew in the context of digital communications techniques in the next round of inquiry.

Digital grows taller every day.

—Don Bishop

Chronology

- Dec. 8, 1983**—U.S. Congress' *Federal Communications Commission Authorization Act of 1983* directs the FCC to consider public safety spectrum allocation requirements.
- March 7, 1984**—FCC issues a *Notice of Inquiry* into public safety communications needs.
- Aug. 1, 1985**—FCC *Staff Report* suggests options, including allocation of 821MHz to 825MHz and 866MHz to 870MHz for public safety.
- July 24, 1986**—FCC *Report and Order* allocates 6MHz worth of 800MHz spectrum for public safety use. Licenses await approval of national and regional plans.
- December 1986**—FCC establishes the National Public Safety Planning Advisory Committee (NPSPAC) to advise it regarding a national plan.
- March 31, 1987**—NPSPAC submits its initial report.
- May 15, 1987**—FCC *Notice of Proposed Rulemaking* proposes policies and rules for the national plan.
- September 1987**—NPSPAC submits its final report.
- Nov. 24, 1987**—FCC adopts a national plan.
- April 25, 1988**—Open Architecture Radio for Public Safety (OARPS) "Call to Action" draws attention to the national plan's lack of trunking standards.
- April 28, 1988**—General Electric files with the FCC a *Petition for Limited Reconsideration* of the lack of trunking standards.
- Aug. 12, 1988**—New York Metro, Dallas-Fort Worth and Florida representatives present the first regional plans to FCC officials.
- Sept. 7, 1988**—FCC issues *Notice of Inquiry* into trunking standards.
- Feb. 22, 1989**—FCC issues a *Memorandum Opinion and Order* that uniform standards for analog public safety communications are not necessary, but states its intention to issue a *Further Notice of Inquiry* into advanced public safety communications technologies.

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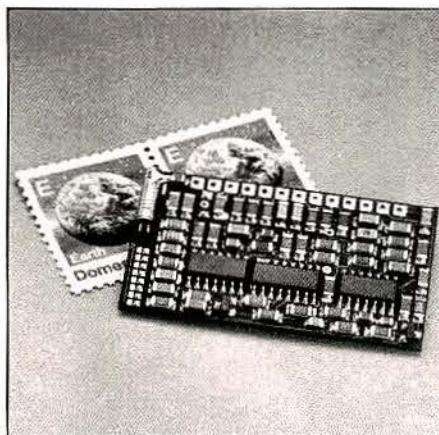
"Perfect...on demonstrations the scramblers sell themselves...real high quality...." (Dealer in Kentucky)

"Working very well...now every police officer wants the extra security...a real nice security addition to our system...." (Police Department in Kansas)

"Nothing but good and great things to say...they work beautifully...we'd love to tell others about them...they're great!" (Police Department in Washington state)

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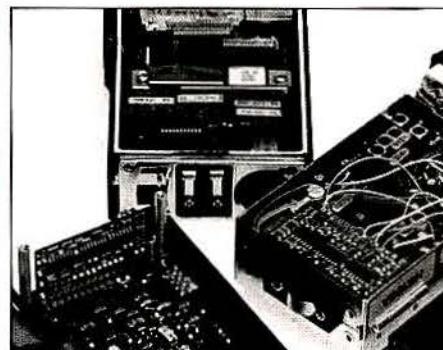
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This service meets our needs *most* of the time. But when I travel outside the area, it is difficult for anyone to reach me by pager.

It would be great if there were some cooperative arrangement among paging companies so when I travel to other areas in the United States, or perhaps internationally, I could call the local paging company's office, tell a customer service representative where I am going, and receive an access number for the area where I will be traveling.

My local paging company would notify the other company of my frequency and paging code. I would be billed an appropriate amount to compensate the two companies for processing the order.

This sort of arrangement would be quite economical for my two or three yearly trips outside the state.

Harold Hallikainen
Hallikainen & Friends
San Luis Obispo, CA

Looks like you've finally done it—printed something that hits a tender spot. Klaus Spies' letter, printed in this column in November 1988, proclaims the benefits of using lower-priced test equipment.

I am a product of 30 years of communications maintenance, and I have faced many situations where test equipment has played an unforeseen role in a test or repair.

Something as simple as a voltmeter (VOM) can give misleading readings. An inexpensive VOM I was using in a high-RF environment read mid-scale with no circuit connection, although a Simpson 250 functioned normally.

I could list many similar occurrences with test equipment, but suffice it to say that, from the standpoint of getting my job done properly, repeatably and rapidly, I prefer high-quality equipment.

Early in my career, I was fortunate enough to be assigned the responsibility of calibrating instruments. The experience gave me insight as to how instruments function, how they are adjusted and their limits. I also learned that published specifications are not necessarily the bottom line when it comes time to apply an instrument to a task.

As I get older, I like less and less to be fooled by an inexpensive instrument, or to run up against a limit it has imposed.

Reliability is a major consideration. To make a service call to a location 40 miles away, only to find that a broken or balky test instrument prevents completing the work, is costly and frustrating.

Mobile Radio Technology

The journal of mobile communications technology

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Letters to the editor

High-quality test equipment is expensive and probably overpriced, but full compliance with specifications, reliability and absence of glitches are several reasons that justify the cost.

Richard Pfahl
Telecommunications Designer
El Cajon, CA

Because of our remote location, we

must rely on sales literature for most purchases. We need *truthful* and *meaningful* specifications.

Richard R. Smith
Smith Electronics
Salmon, ID

The toughest problems we face are limited frequency allocations for public service communications and a lack of

technological advances in lowband VHF equipment.

Brian J. Adams
Community Ambulance Association
Ambler, PA

Radio manufacturers do not provide enough technical assistance. It is a challenge keeping up to date with service techniques for new products.

Alphonse E. Osowiecki Jr.
Collingswood Communications
Collingswood, NJ

You're offering good general coverage of articles—technical, mixed with information-type.

Interference is growing at mountain-top sites because TV stations allow any piece-of-junk land mobile base station to locate on their towers. I wish the TV stations were affected by intermod!

Frederick A. Mahone
Electronics Technician
Salem, VA

I am very involved in the design and installation of radiopaging systems. I need more information on those types of systems, especially antenna types, performance and placement on lowband VHF and 900MHz paging systems.

The toughest problem is deciding what, where and how to install a tri-state paging system because this is a major expense to my customers. There is no room for error and no changes can be tolerated.

Gary M. Carrer
The Radio Exchange
Newton, NJ

I would like to see more articles on the technical repair of hand-held transceivers, paging receivers and mobile units.

Two articles in the November 1989 issue were of particular interest: "New Scopes Make Faster Measurements" and "Performance Testing for Base Receivers."

The toughest problems are competition from the 1W and 2W hand-held transceiver manufacturers and competition from manufacturers of cheap equipment.

John Culver
Skyline Communications
Hayden, AL

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‘What’s the range of my pager?’

Pagers have no range, in and of themselves. Paging systems have coverage areas. No matter. Systems equipment buyers still want to know the range of the pager. Here’s how to answer the question.

By Jim Hathaway and Roy Holmes

“What’s the range of this pager?”

The question often is asked by potential or current paging system operators.

“How far can it receive paging messages?”

Simple question. We *know* what the question means. But the answer is not easy.

Why do paging system equipment customers find the “range of the pager” so important? Because the system’s *coverage area* embraces the population of potential paging service subscribers. Because revenue predictions are based in part on a calculated percentage of the population the system serves.

Range and *coverage area* are related. They are unique in every circumstance: The coverage area depends on the paging system’s antenna, antenna height, transmitter power, frequency; the terrain and building composition in the area it serves; and the kind of pagers used.

The pager has no range, in and of itself. You can operate the same pager in two locations with different conditions and find its operation is not the same in each location.

Instead of range, then, manufacturers specify the pager’s *sensitivity*. Sensitivity describes the weakest signal the pager can receive.

Nevertheless, customers really want to know the range, meaning how far away from the transmitting antenna they

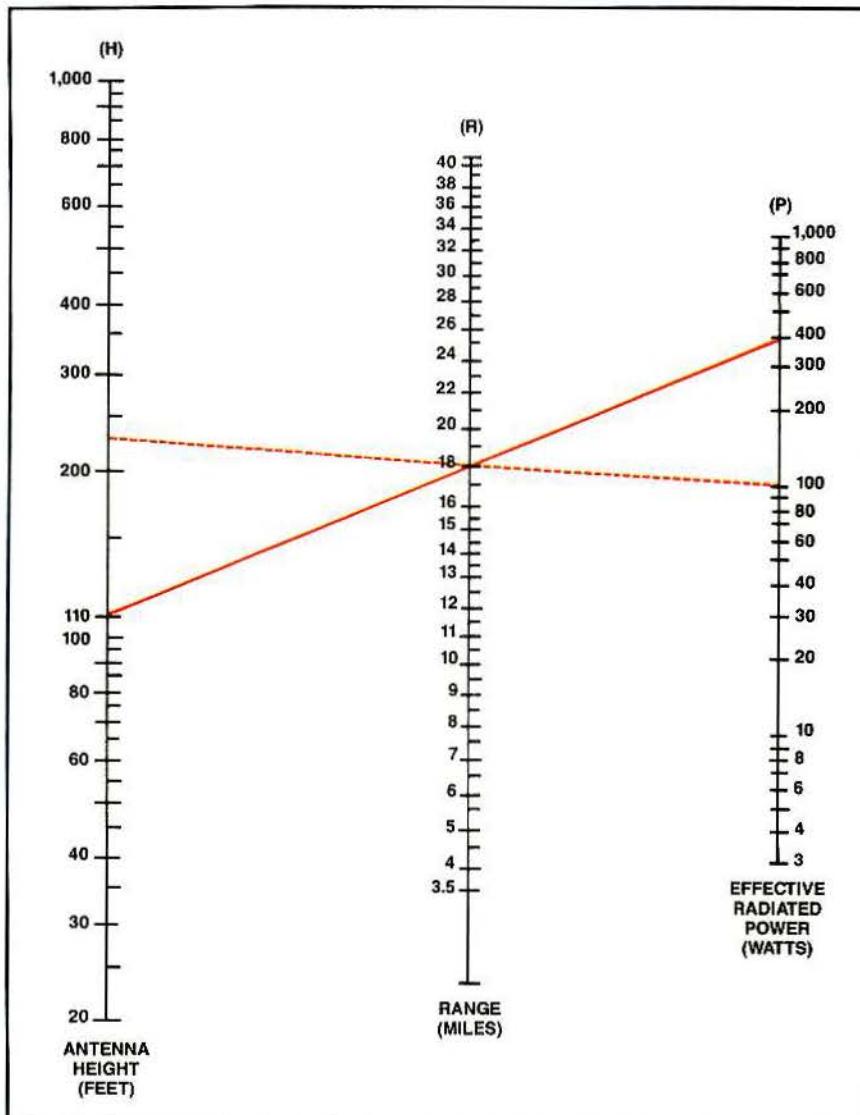


Figure 1. Nomograph for estimating mobile radio system range, assuming the receiver sensitivity is $5\mu\text{V/m}$, the receiver antenna height is 6 feet and the operating frequency is 154MHz. Instructions: Draw a line from (H) to (P) and read range on (R).

Hathaway is the technical writer and advertising manager at Reach Electronics, Lexington, NE. Holmes is a senior engineer.

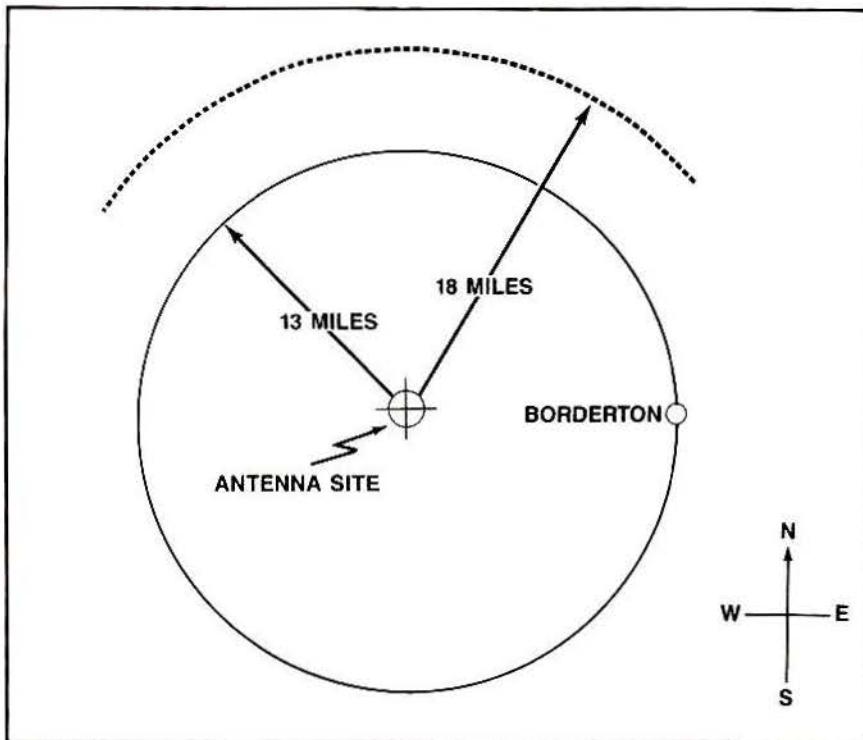


Figure 2. Coverage area for a model rural paging system.

may go and still expect to receive a page.

To describe the "range of a pager," various tables and graphs may be used. Let us first use these tables and graphs to estimate the coverage area of a model, hypothetical paging system. The simplest system is in a rural area with flat terrain and no large buildings or other structures.

Simplified range estimates

Figure 1 on page 11 shows the simplest tool for estimating any radio system's range, including paging systems.

The nomograph was designed for estimating the range of systems serving mobile two-way radios whose antennas are mounted on vehicle rooftops. Pagers, on the other hand, normally are carried so their antennas are about 3 feet off the ground. Thus, some allowances have to be made in using Figure 1 to predict pager range.

Here are some assumptions about the model paging system:

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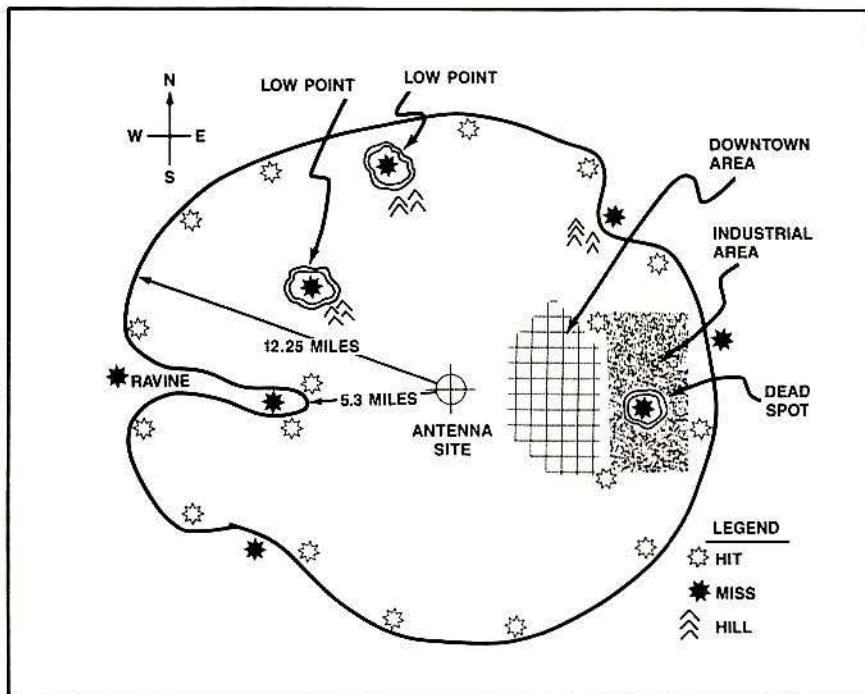


Figure 3. Coverage area of a 'composite' model of several urban paging systems, based on field tests.

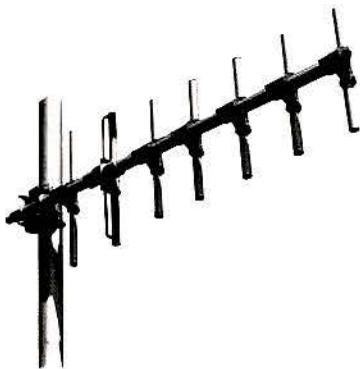
Its frequency is 154MHz.
The pager's sensitivity is $5\mu\text{V/m}$.
The transmitter broadcasts with 400W effective radiated power (ERP).
The antenna is 110 feet above the ground.

Apply these assumptions to the nomograph. Draw a line between the point that represents 400W on the line at the right and the point that represents 110 feet on the line at the left. A line drawn in this fashion intersects the line in the center at a point that represents 18 miles.

Eighteen miles, in theory, represents the range of the system if it serves mobile radios.

Height vs. power

Notice something interesting: the dashed line in Figure 1. It shows that when the transmitting antenna's height is doubled, only one-fourth the power is required to cover an 18-mile range. This relationship shows that the transmitting antenna's height has more



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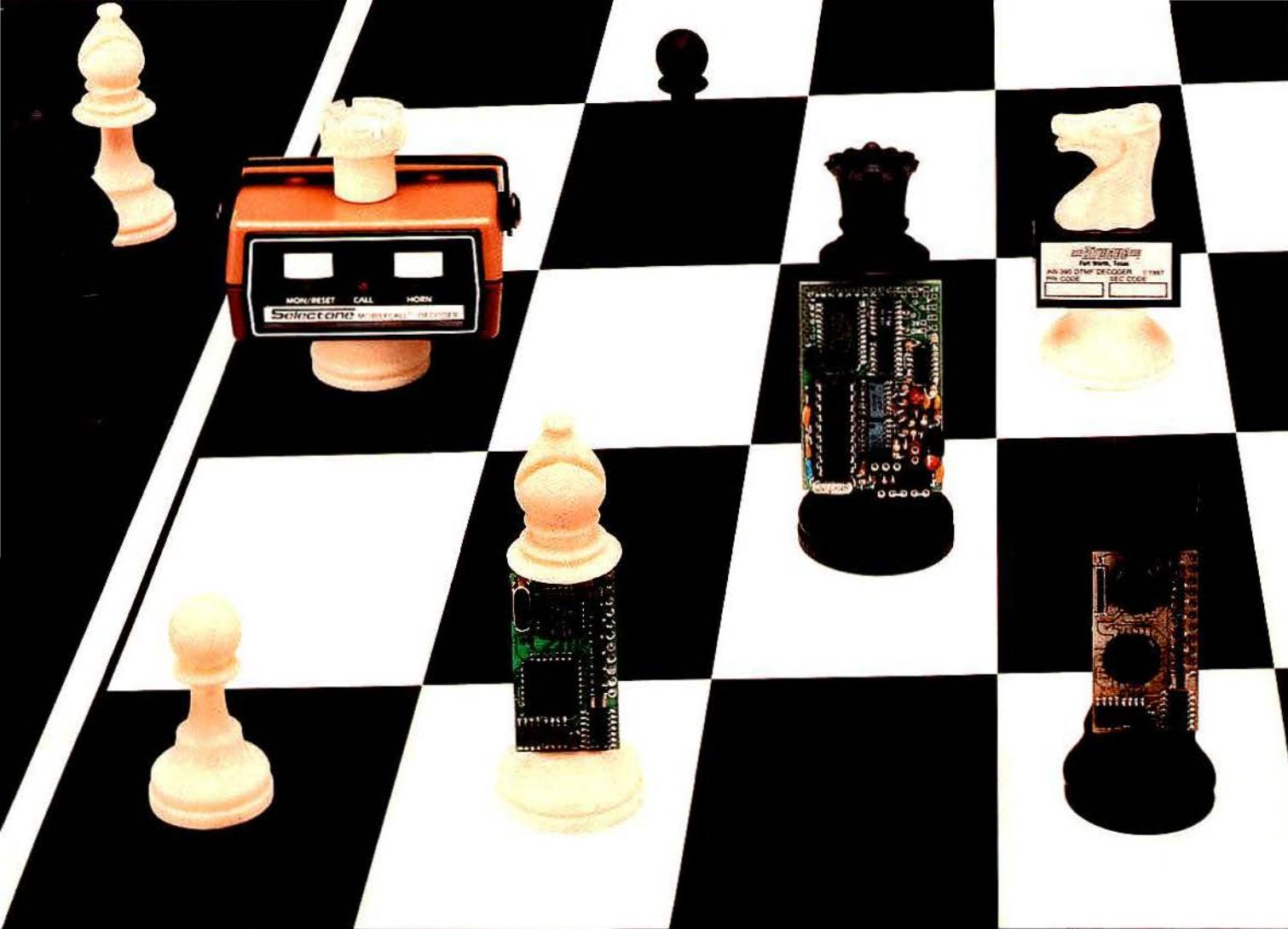
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of an effect in extending range than transmitter power. To a certain degree, the same principle applies to the pager antenna height's affect upon range.

Figure 2 on page 12 shows the difference in range between two-way radios in vehicles and for pagers on the model system. Mobiles, with their antennas about 6 feet above the ground, have a range of about 18 miles. But pagers,

with their antennas 3 feet above the ground, have a range estimated to be about 13 miles—considerably less.

The information shown in Figures 1 and 2 initially may answer the customer's question, "What is the range of this pager?" Yet the question represents an oversimplification.

In practice, the coverage area rarely would conform to a true circle. The

coverage area would have some irregularities, and some "dead spots" where a signal might not reach, even though it may be received once again at some distance beyond the dead spot. Hills, valleys, structures and other factors are to blame.

Fringe area

Precision in predicting range, especially in the fringe area, is problematic. Look once again at Figure 2, and consider this example:

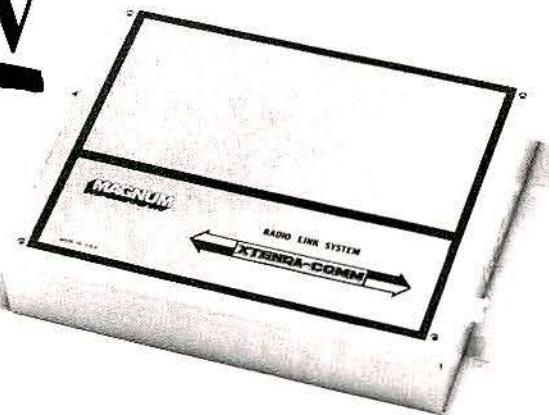
Notice that the small town of Borderton is bisected by the 13-mile contour

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If you could receive a page on the west side of the street, would you still receive a page after you cross the street?

line. Imagine that you are in Borderton, just inside the coverage area. Then you cross the street, leaving the coverage area.

If you could receive a page on the west side of the street, would you still receive a page after you cross the street? The question raises an important point. The outer reaches of a coverage area is not a sharp line as it is drawn on a map. In the Borderton example, you might not receive a page anywhere in town or, conversely, reception might be satisfactory. Alternatively, you might receive a page in one place yet, when you merely turn around in the same spot, reception might be gone.

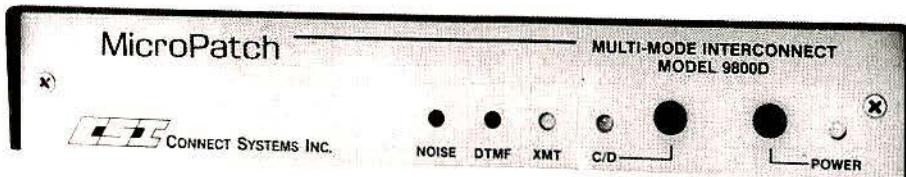
'Composite' urban system

Suppose it were possible to pick up the antenna tower and transmitter of the model paging system described by Figure 2 and transport them to a medium-sized city. Would the *range* be the same?

Figure 3 on page 14 shows what the

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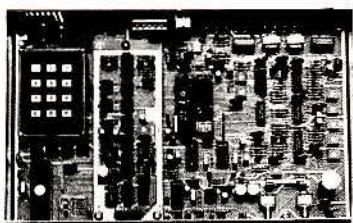


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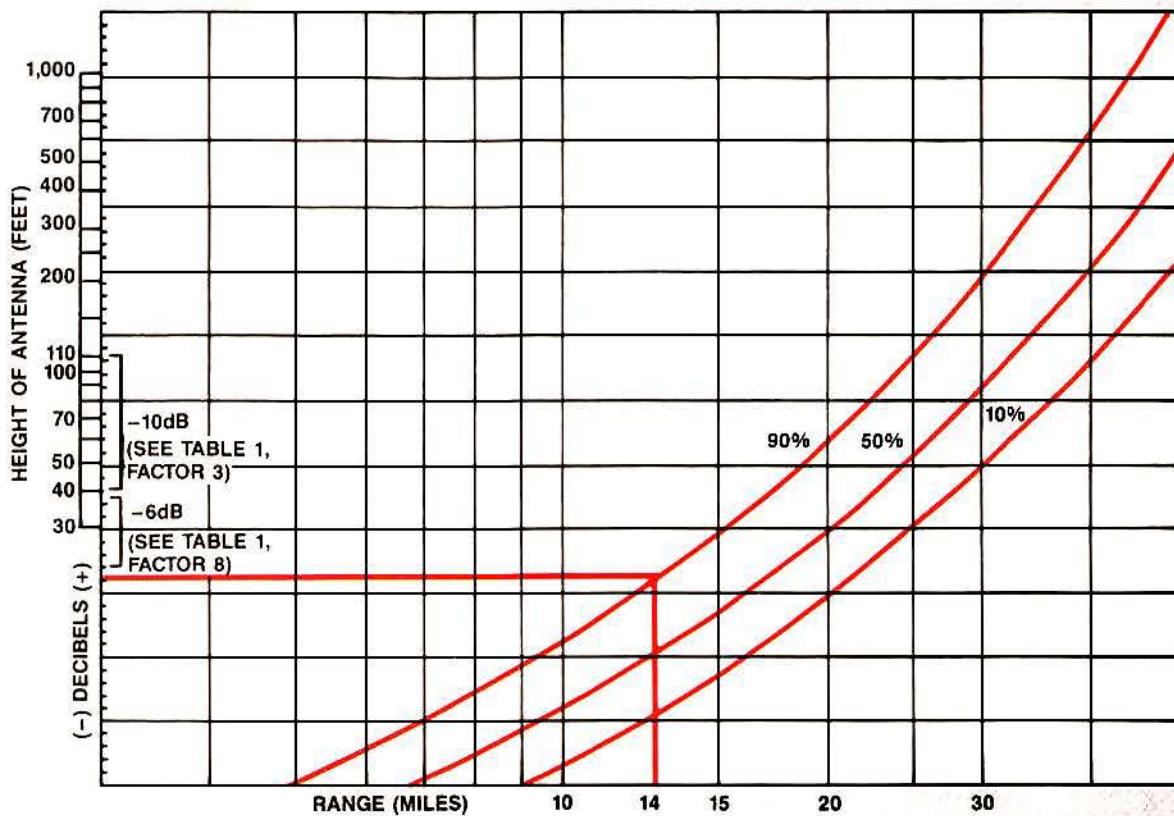


Figure 4. Use this graph to predict a paging system's range. Instructions: Begin by locating the point on the vertical scale corresponding to the antenna height. Add or subtract decibels along the vertical scale according to correction factors shown in Table 1 on page 20. From the point on the vertical scale in-

dicated by the correction factors, draw a horizontal line that intersects with a curve that represents the desired reliability percentage. Draw a vertical line downward from this point to intersect the horizontal scale. Read the range on the horizontal scale.

A 9.5-mile radius is considerably less than the range of the model rural system shown in Figure 2.

It is clear that the most limiting factor of the urban system's range is terrain. But other factors are important, too.

The "dead spot" in the industrial area is to be expected. Thorough field testing in a city similar to the one in this example probably would reveal more such dead spots. Usually, dead spots are caused by a combination of factors, not terrain alone, although in some cities the industrial areas occupy the low ground.

Industrial buildings commonly are large, and they are built with steel, sided with steel or roofed with steel. Other industrial structures, such as storage tanks, interfere with paging signals.

Most large cities have downtown areas with tall buildings that make reception of VHF highband signals in the

downtown area difficult. Reception of VHF lowband signals is even more difficult.

Industrial structures, such as storage tanks, interfere with paging signals.

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The nomograph in Figure 1 takes *none* of these factors into account. All it indicates is that with a transmitting antenna at a given height and with a coverage area might look like for a city with typical coverage problems. The coverage area encompasses a long and deep ravine, an industrial area, some hills, some low spots and some flat terrain.

The figure actually represents a composite of several urban paging systems where tests have been conducted and documented. The figure summarizes the test results.

As the figure shows, the greatest distance from the transmitter antenna at which pages would be received reliably is 12.25 miles. The shortest "range" in one direction is 5.3 miles.

Except for the area inside the ravine, the reliable coverage area can be described as a radius of about 9.5 miles.

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Table 1—Correction factors for use with the decibel scale in Figure 4.

POWER LEVELS

1. If ERP is greater than 400W:
 - (A) 500W—add 1dB.
 - (B) 1kW—add 4dB.
2. If ERP is less than 400W:
 - (A) 300W—subtract 1.25dB.
 - (B) 200W—subtract 3dB.
 - (C) 100W—subtract 6dB.

RECEIVER LOCATION

3. In urban area (city streets):
Subtract 10dB.
4. In downtown area:
Subtract 20dB.
5. In a factory or warehouse:
Subtract 12dB.
6. In a modern office building, first floor:
Subtract 40dB.
7. Inside automobile or truck:
Subtract 12dB.

RECEIVER TYPE

8. If the receiver is a pager:
Subtract 6dB.
9. If the receiver is a mobile unit:
No correction.

given ERP, a certain range may be expected. As the examples of the rural and urban systems show, simplistic calculations of range are misleading.

Figure 4 on page 18 shows a better graph to use for calculating range. It is more complex, but it takes into account the factors not considered by the model system. Figure 4 can be used to indicate whether satisfactory reception is probable in a given location. For example, it can be used to indicate the quality of reception inside a certain type of building, or an automobile.

The starting point for using the graph is the vertical column of figures at the left. Select a point along the column that corresponds to the height of the transmitting antenna.

Notice that the next vertical line is marked in increments that correspond to decibels. The decibel scale is the key to using the graph. Each one of several variables adds to or subtracts from the decibel value indicated by the starting point on the graph.

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For example, the starting point on the vertical scale is based upon a transmitter ERP of 400W. Use the decibel scale to correct the starting point for other transmitter ERPs. Correction factors are defined in Table 1 on page 20.

More range factors

Other factors that affect range are listed, together with how many decibels to subtract from the starting point.

Take for example a system with a 110-foot antenna height. The signal is to be received by a pager on a street in an urban area.

The starting point on the vertical scale is just to the right of the 110-foot antenna increment. From that point is subtracted 10dB, the correction factor for urban street reception. Another 6dB is subtracted as the correction factor for using a pager as a receiver.

From the corrected starting point on the vertical scale, draw a horizontal line to the right until it intersects one of the curves. The curves represent paging

reliability levels at which 10%, 50% or 90% of the pages sent are received. From the point where the horizontal line intersects the curve labeled "90%," draw the line straight down until it intersects the horizontal scale.

The horizontal scale indicates a range of about 14 miles, which is the range expected for a paging system similar to the one shown in Figure 3.

But Figure 3 shows 12.25 miles as the greatest distance served in the coverage area. Why the discrepancy?

First, the assumptions that underlie the graph in Figure 4 include a terrain model with hills that may limit range severely.

Second, Figure 3 does not represent a system operator who is satisfied that only 90% of the pages transmitted are received. For greater than 90% reliability, the predicted range is somewhat less. The figure of 12.25 miles conforms to data derived from field tests on a paging system similar to the one described in the example.

Graphs, tables and other aids can help to plan a paging system. But they are no substitute for field tests. Pagers may be borrowed from Reach Electronics' sales department for field tests, subject to certain limitations.

Part 2, the concluding installment in this article series, covers additional factors affecting range. Among them are the effects of building size, configuration and composition that affect signal penetration. Others include range differences between paging signals carried by broadcast FM subsidiary carrier authorization (SCA) or by conventional VHF lowband, VHF highband or UHF paging transmitters.

Reference

1. Gifford, Gary; James L. Griffith, P.E.; and Roy L. Holmes, "Individuals, Environment Play Roles in SCA Paging," *Mobile Radio Technology*, February 1988.



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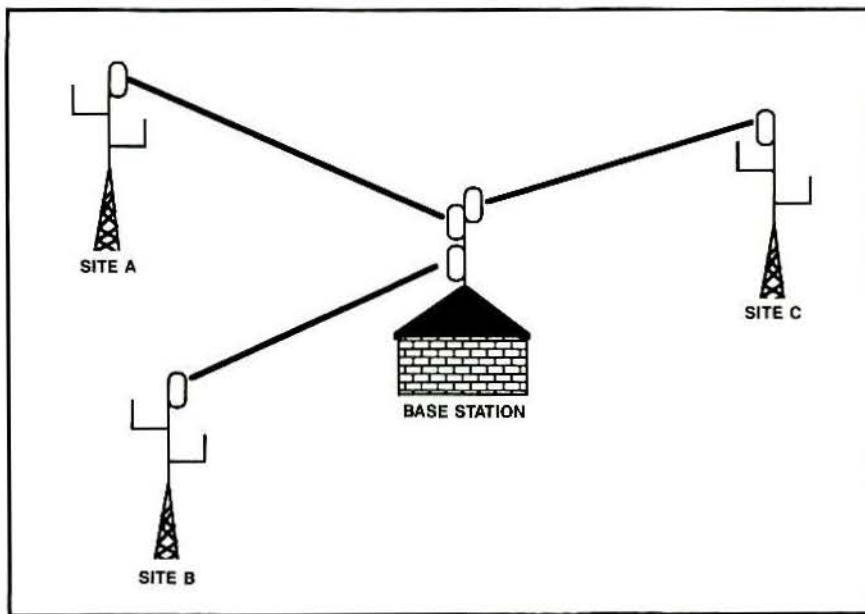


Figure 1. Trunksed radio system operators use relay links to connect multiple sites into networks. The network may be connected via microwave to the office for accounting and billing functions and to an operations center for control, programming and troubleshooting functions.

By Jim Screeeden and Dave Babbitt

Operators of land mobile radio systems, including conventional two-way radio, trunksed two-way radio, radiopaging and mobile telephone systems, can exploit advantages short-haul microwave relay links offer.

Relay links most often replace telephone lines to avoid recurring line charges or because suitable telephone service may not be available.

The authors are employed by Motorola Communications Sector, Schaumburg, IL. Screeeden is area sales manager, telecommunications systems; Babbitt is account executive, carrier markets.

Trunksed radio system operators use relay links to connect multiple sites into networks. (See Figure 1 above.) The network may be connected via microwave to the office for accounting and billing functions and to an operations center for control, programming and troubleshooting functions.

Paging system and trunking system applications are similar. Even conventional two-way systems may use relay links to carry signals and data that might otherwise be transported via telephone lines. (See Figure 2 on page 26.)

Standard microwave

Some of the first microwave relay

links manufactured use 4GHz, 6GHz and 7GHz frequencies. An advantage these frequencies offer is a range as great as 30 miles. But with extended range come certain difficulties and costs.

The 4GHz to 7GHz links use antennas 6 feet to 10 feet in diameter. Aside from a higher initial cost, the antennas require stronger structures to support them and to keep them properly aimed under wind stress.

Because these frequencies have been in use longer, new licensees must engineer their links so they do not interfere with established users. Crowding in some areas makes the engineering difficult and more costly.

'Short-haul' microwave

To overcome problems associated with antenna size and path engineering, some system operators use frequencies in the 18GHz and 23GHz bands.

Depending on how and where they are implemented, these frequencies ordinarily have a limited range of 1 mile to 15 miles (hence the name "short-haul"). But many land mobile system requirements fall well within the reliable range of 18GHz and 23GHz links.

The links use smaller antennas, usually no larger than 4 feet in diameter. Installation involves less time and expense. The smaller antennas may be placed on a tower, a rooftop or even behind a window.

Less crowding at the higher frequencies makes engineering simpler and makes communications less likely to suffer interference.

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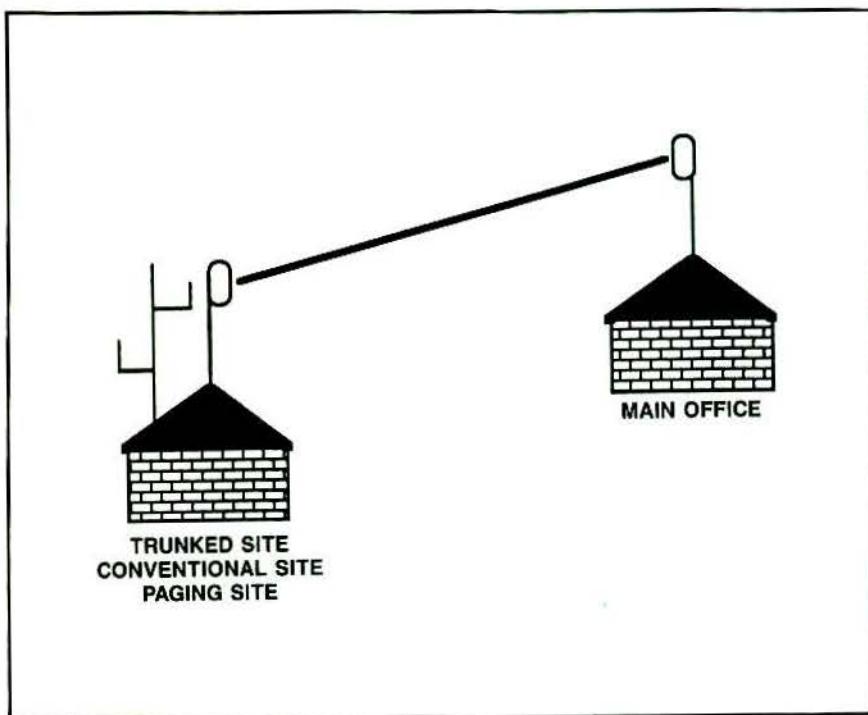


Figure 2. Trunked, conventional and paging systems use microwave relay links similar to carry signals and data that might otherwise be transported via telephone lines.

vantage of the latest *modular* hot-standby techniques. If a link equipped with a hot-standby fail-safe backup suffers a failure, only the necessary *module* from the hot-standby unit is switched into the circuit. This improves the "no tools required" troubleshooting procedure that allows the user to maintain a network via module replacement.

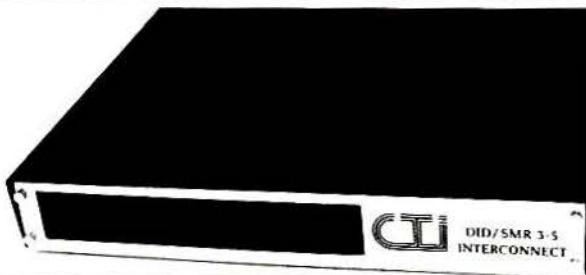
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Customer: ABC Company	User: Production		
Engineer: D. Babbitt	Date: XX-XX-XX		
Transmitter/Receiver Sites	Houston	--to--	Montgomery
Latitude	30-1-1		29-58-54
Longitude	90-1-1		89-58-35
Ground Elevation (AMSL.)	50.00 ft.		125.00 ft.
Antenna Size	2.00 ft.		2.00 ft.
Antenna Gain	39.30 dB		39.30 dB
Antenna Beamwidth	1.50 deg.		1.50 deg.
Antenna Height (ABL)	120.00 ft.		100.00 ft.
Antenna Azimuth	134.97 deg.		314.99 deg.
Antenna Tilt	0.15 deg.		-0.20 deg.
Transmission Line Type	None		None
Transmission Line Length	0.00 ft.		0.00 ft.
Transmission Line Loss	0.00 dB		0.00 dB
Effective Radiated Power	56.80 dBm		-----
Calculation Frequency		23000 MHz	
Path Length		3.44 miles	
Free Space Loss	134.57 dB		
Transmission Line Loss	0.00 dB		
Alignment Factor	2.00 dB		
Transmit Branching Loss	0.00 dB		
Receiver Branching Loss	0.00 dB		
Atmospheric Absorption	1.28 dB		
TOTAL Loss	137.85 dB		
Transmit Power	17.50 dBm		
Antenna Gains	78.60 dB		
Receiver Sensitivity	-80.00 dBm		
TOTAL Gains	176.10 dB		
Received Carrier Power	41.75 dBm		
Fade Margin	38.25 dB		

Figure 3. Many equipment manufacturers provide comprehensive software programs that allow users to view relay link configurations on a computer cathode-ray tube (CRT). This computer printout shows a fade margin calculation for a specific equipment configuration.

gain to compensate for signal fading caused by rainfall.

Many manufacturers publish rain rate tables that may be used to estimate recommended path lengths. The tables reveal the maximum distance recommended for reliable transmission. They take into consideration regional rainfall averages. Based on the reliability you require and your specific location, the tables help you to decide whether 18GHz and 23GHz relay links can satisfy your requirements.

For many mobile radio system planners, microwave links of T-1 or less can provide the capacity needed to carry their trunking networks. A T-1 link provides as many as 24 circuits. Allowing for two or three interconnected lines per 10 mobile channels, a digital microwave T-1 system offers the ability to trunk 80 mobile channels or a variety of radio tie lines for base station and satellite receiver networks. This capacity offers enough channels for many current applications and provides for future network expansion.

Many equipment manufacturers provide comprehensive software programs that allow users to view relay link con-

Technical assistance

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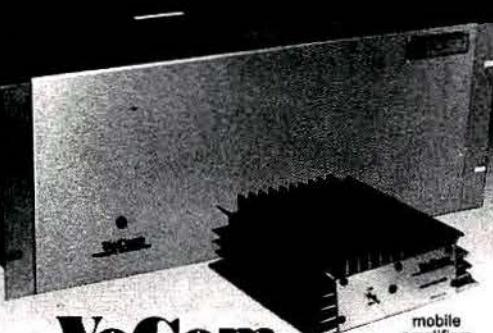
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figurations on a computer cathode-ray tube (CRT) and to select the best alternative for precise system requirements. (See Figure 3 at the top left.)



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Comparison chart

4GHz, 6GHz and 7GHz microwave

- require antennas from 6 to 10 feet in diameter.
- extend range to 30 miles.

18GHz and 23GHz microwave

- use antennas that rarely exceed 4 feet in diameter.
- fit applications that require less range.

Users may draw on assistance from other companies as well for help with frequency coordination and license application processing. A list of companies appears on page 28. Usual charges are about \$500 for each relay link path. The FCC license processing

fee is \$135 per site; each path normally has two sites. Licenses ordinarily are issued in 60 days.

Land mobile system operators have much of their system under their control. The exception, in some cases, lies in the use of telephone lines as a com-

munication and control medium between equipment sites.

Microwave relay links are more than just an alternative to telephone lines. They offer a means of bringing the entire land mobile radio system under the control of the operator. Relay links form an integral part of a reliable, economical communication network solution. 

Additional reading

1. Matz, John E., "23GHz Microwave Propagation Effects," *Mobile Radio Technology*, April 1987.
2. Matz, John, and Paul Erickson, "Installation & Optimization of Two-Way Microwave Systems," *Mobile Radio Technology*, November 1986.
3. Roelofs, Stan, "Fade Margin Requirements for Microwave Systems," *Mobile Radio Technology*, December 1986.
4. Stedman, Robert B., "Microwave Subsystems Boost Two-Way System Coverage," *Mobile Radio Technology*, September 1986.

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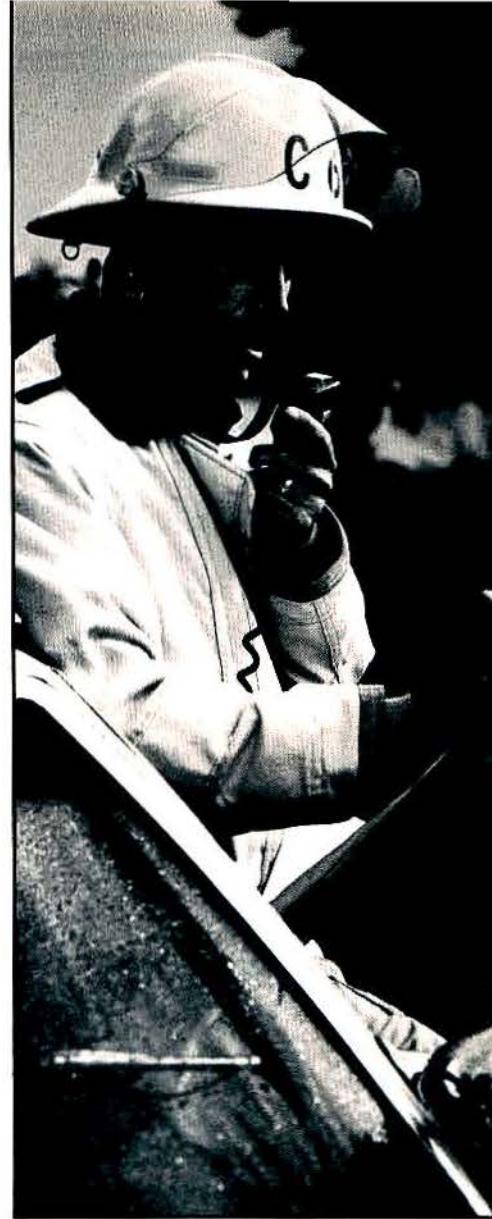
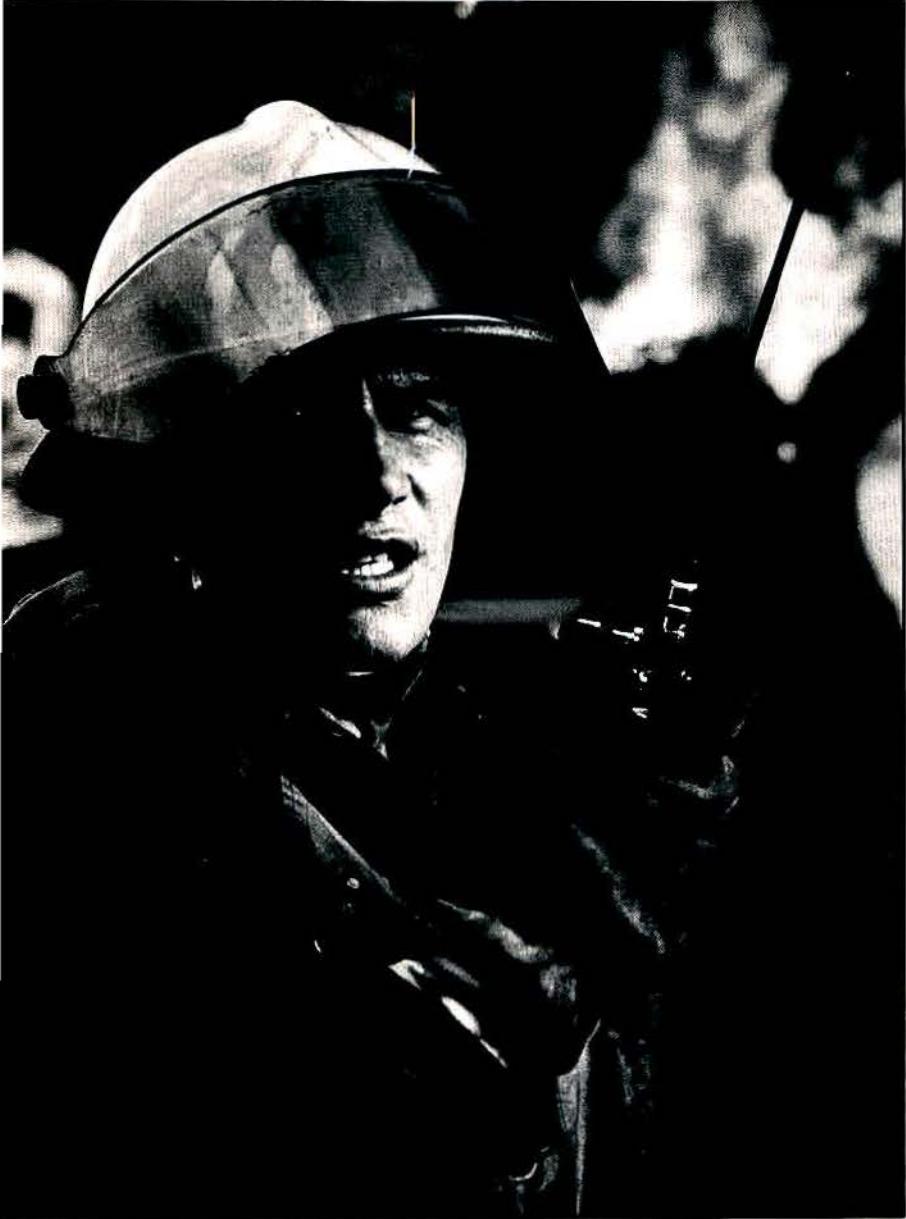
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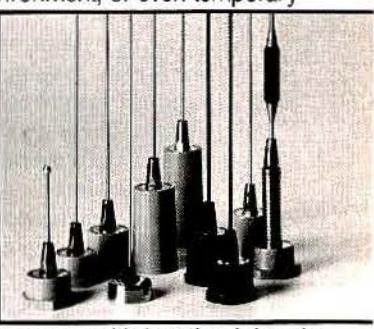
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Networking protocol links voice paging systems

Medium-to-small paging system operators who offer primarily voice service can extend network coverage to their subscribers. Telocator's network paging protocol makes voice networks practical.

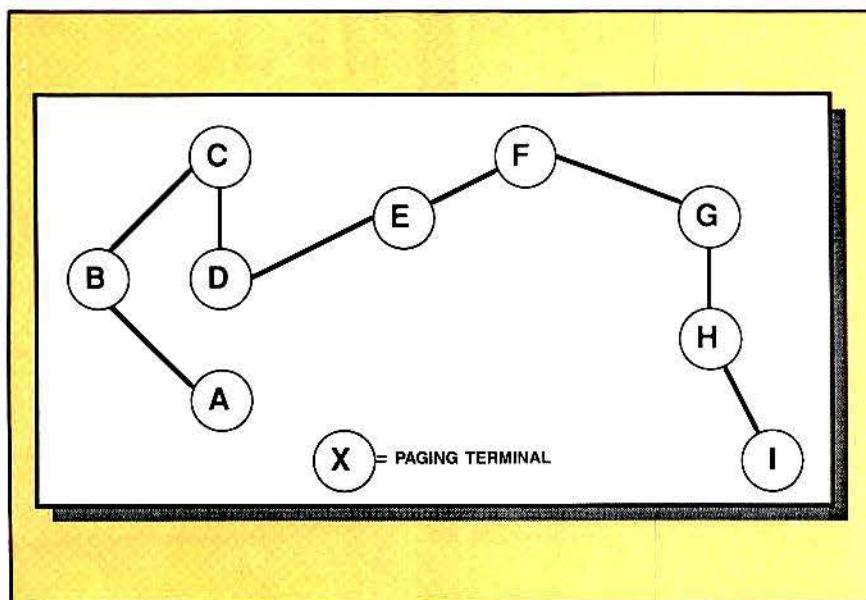


Figure 1. Single line configuration of paging terminals adapts to network voice paging. Interconnection to another network may be made only at the ends, terminals A or I.

By Don Arnold

Paging system operators can set up wide-area paging networks using various manufacturers' paging terminals. These networks allow them to expand the coverage areas offered to their customers.

A practical network protocol has been developed; paging terminals that use the protocol are being made.

Medium-to-small systems make the greatest use of voice paging, and many

subscribers need wide-area coverage. The need makes networking voice paging desirable.

Telocator protocol

Telocator, a trade association of paging and mobile telephone system operators, in conjunction with the Telocator Manufacturers and Exhibitors Association, spearheaded the development of a protocol that allows one paging terminal to send a paging message to a network of other terminals regardless of manufacturer. The Telocator Network Paging Protocol (TNPP) also enables system operators to share billing and other management information. The protocol was adopted

Arnold is president and chief engineer of Commonwealth Communications Industries, Ashland, VA. He participated on the TNPP protocol development committee.

in late 1986 by the U.S. paging terminal manufacturers.

As recently as July 1988, the voice paging networking allowed by the protocol was being implemented by only one manufacturer, Commonwealth Communications Industries. Voice paging capability allows the protocol to be put to work in medium-to-small systems.

Using the protocol's voice paging feature is simply a logical extension of the other paging formats handled by the protocol. But when voice paging is used on a network, some restrictions must be met, including network configuration and the number of terminals in the network.

Network configuration

As shown in Figure 1 at the left, the network must be configured as a single line of terminals. It cannot include a "star," as shown in Figure 2 on page 34. A star configuration results when more than two terminals connect at a single location.

The star configuration unduly complicates the transition between a data network and a voice network. It prevents efficient control of the system in the allocation of the interconnect path to voice users.

Network configurations that include a star require that each interconnecting point, or "node," in the network possesses a complete set of "routing lists" indicating how to direct calls to every other terminal in the network. Single-line networks do not impose this requirement upon the terminals.

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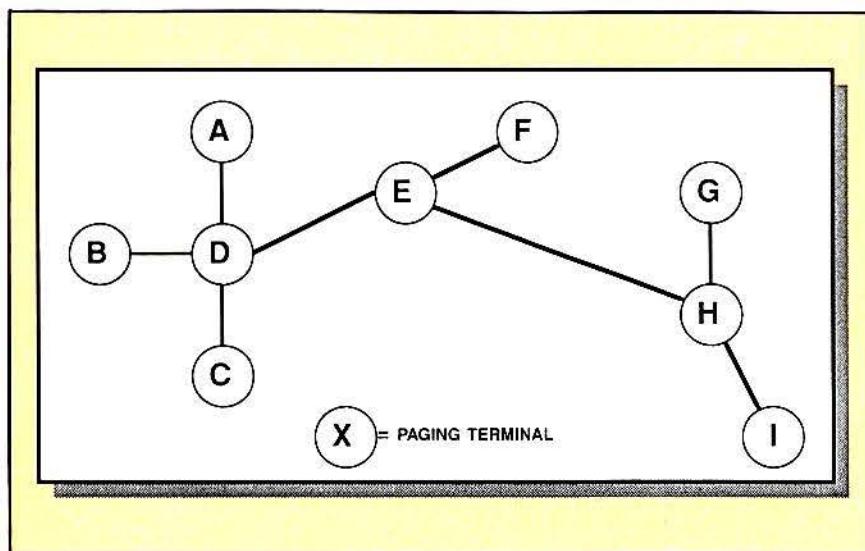


Figure 2. "Star" configuration of paging terminals works with digital signals, but not with voice, under the Telocator Network Paging Protocol. Certain restrictions must be met.

through either type of network configuration; voice pages cannot.

Although nothing precludes mixing the single-line and star interconnection

methods, voice pages only may be passed along those parts of the network that represent a single-line path. The network offering voice paging would in-

terconnect to the non-voice network at one end or the other.

Network interconnection

The first two figures can be used to show how a single-line voice paging network may be interconnected with a non-voice paging network that includes a star configuration.

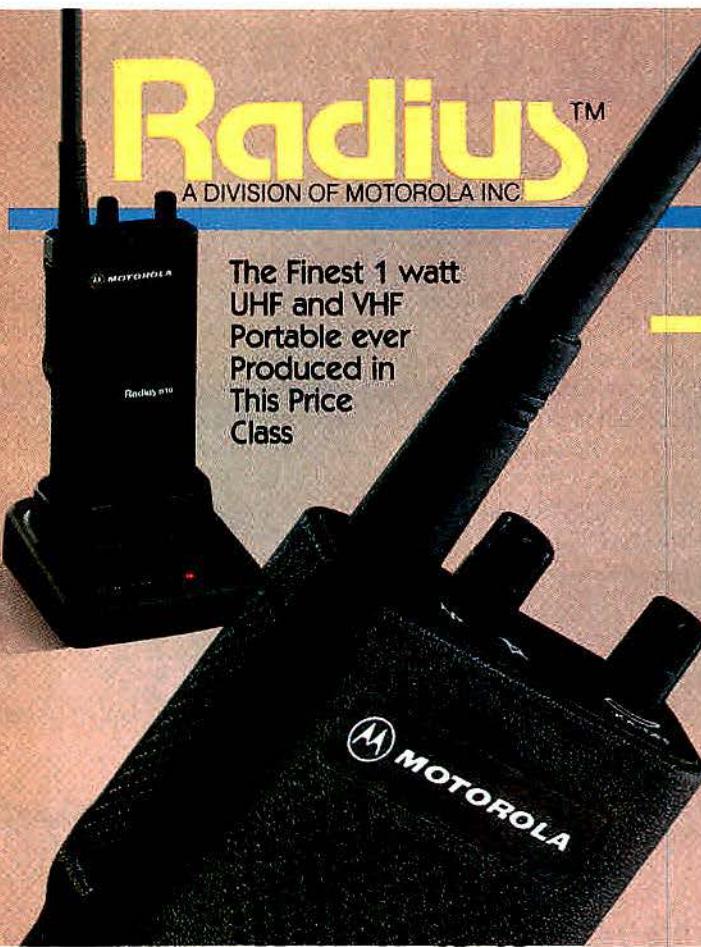
Figure 1's network can support voice paging; Figure 2's cannot.

If connection between them is made with Figure 1's terminal A or terminal I, voice paging on the network remains undisturbed.

It does not matter which terminal in Figure 2's network is used for the interconnection; Figure 1's voice path remains a single line.

Commonwealth terminals are capable of recognizing that Figure 2's network cannot support voice traffic. Voice messages will not pass to that part of the network.

A reasonable limit should be placed on the number of terminals that use the



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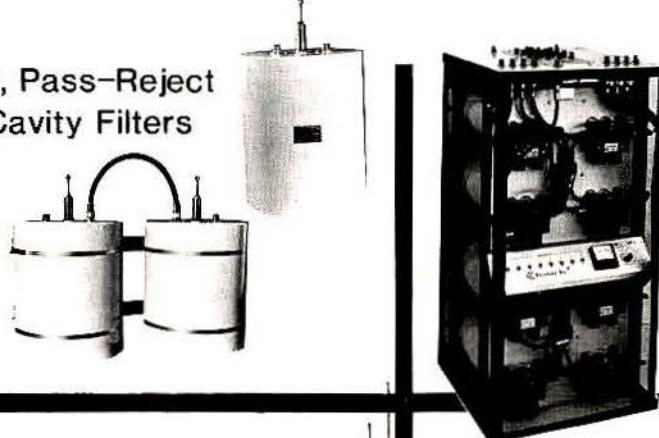
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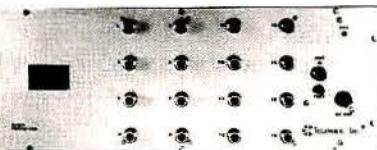
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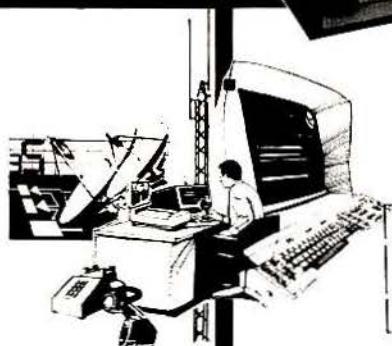
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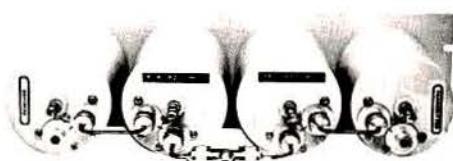
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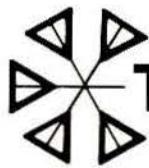


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network voice paging feature so the network will not be overloaded by voice traffic. Each terminal on a voice network intended to receive a voice message must allocate a voice storage recorder to receive the message from the network.

The voice message transmission procedure includes:

- informing one or more terminals that a voice call is being transmitted to them.
- allocating a voice storage recorder at each terminal.
- waiting for an acknowledgment from each terminal that a recorder is available.

The procedure takes time.

Transition periods take time, too, as the network path is converted from data to voice before the message is transmitted, and as it reverts to a data path after a voice message transmission.

In smaller networks and other networks with a low traffic rate, time consumed by voice message transmission and by transition periods are of little

consequence compared to the advantage gained by the network. A network with eight terminals, 300 subscribers who use voice paging and 5,000 subscribers

Voice paging on TNPP requires the synchronization of what is, by nature, an asynchronous system.

Because a transition must be made between data and voice on the network, some coordination is required to maintain order. The coordination is supplied by terminals at each end of the voice portion of the network.

Figure 4 on page 40 shows five terminals connected in a single line to allow voice paging.

A terminal with a voice page to send to other terminals on the network sends a voice page request to each end.

overall, has been operating for more than a year. Voice paging capability often is cited as the reason for forming the network.

When the coordinating terminals grant network time to the requesting terminal, a voice acknowledgment propagates from each end to the requesting terminal. As the voice acknowledgment passes through each terminal en route to the requesting terminal, digital com-

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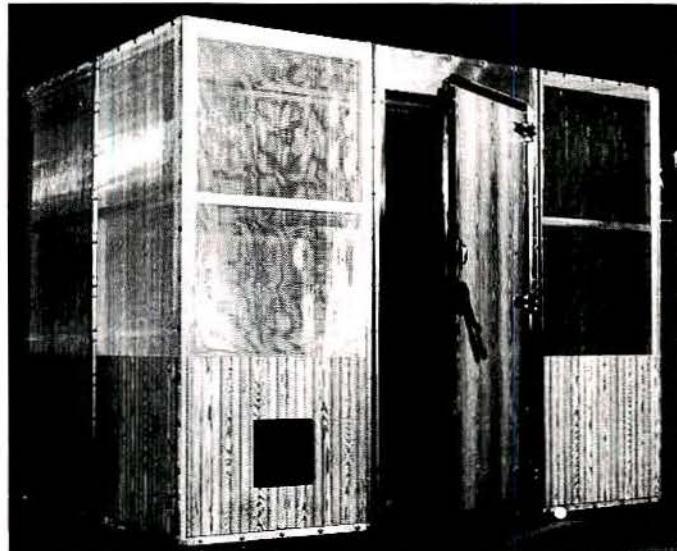
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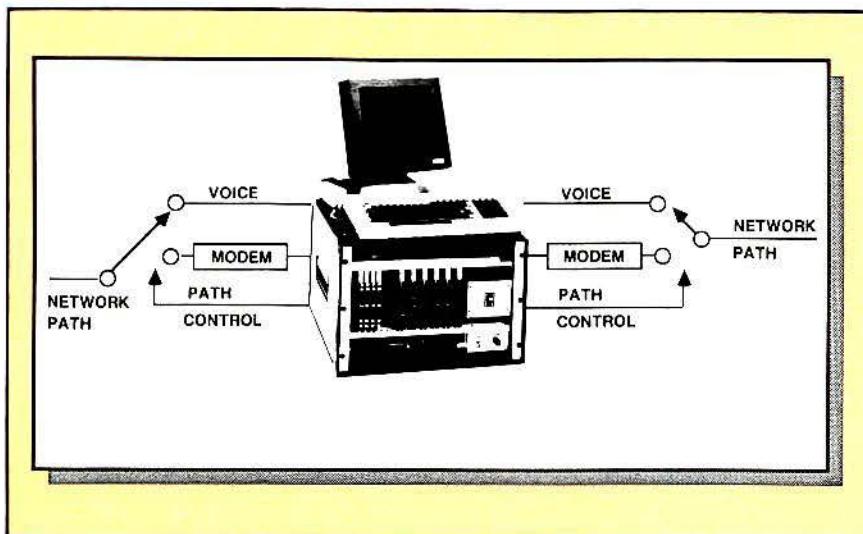


Figure 3. When a voice message is sent over a network line, a paging terminal controls the network line by switching it through the modem for data interconnection or directly into the network interface. The two sides operate independently, thus allowing the interconnection to non-voice networks.

munication "collapses" and the network switches into voice mode.

When the acknowledgments reach the requesting terminal, all digital com-

munication has been suspended. The destination terminals have allocated a voice recorder and are waiting for the voice message. Receipt of the

acknowledgments by the requesting terminal signals that the voice message may be transmitted over the network.

Figure 3 shows how the voice network line switches directly into the terminal for voice messages, or through the modem for data communications. The two sides of the terminal operate independently to allow the interconnection of voice to non-voice networks.

The presence of a voice signal on the network is indicated by a "pilot tone" that accompanies the voice message. The tone is removed from the message before it is recorded at each terminal to prevent it from being heard by the subscriber.

Default timers prevent the network from being tied up by an excessively long voice message or by a defective terminal.

Once the voice message is complete, as indicated by removal of the pilot tone, or the default timers time out, the network reverts to a datalink and normal network traffic resumes.

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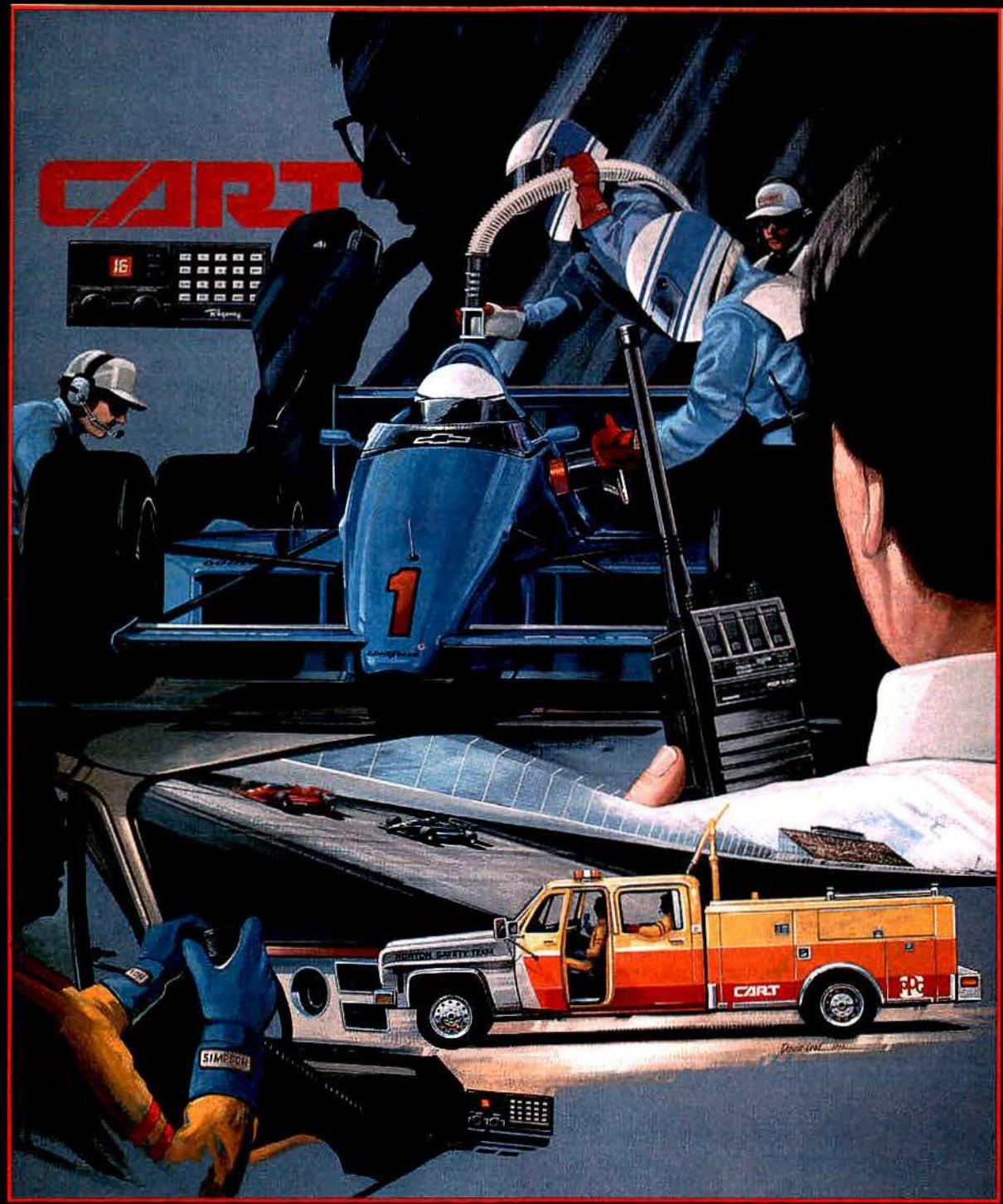
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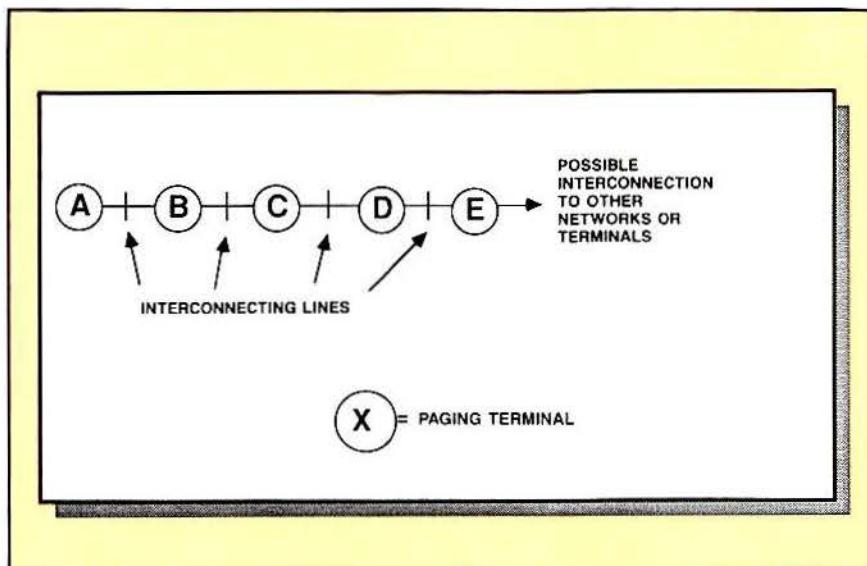


Figure 4. Terminals at each end of a single line network control the allocation of a voice interval on the network. One by one, terminals are switched into voice mode as an acknowledgement is passed from each end of the network to the terminal that requests a voice interval.

voice page is consumed by the voice message itself. Because the network line's bandwidth is narrow, the fastest

method of sending voice is as an analog voice signal in real time. To convert the message to a digital equivalent and send

it as data over the network line would take much more time than does the procedure of switching between voice and data modes.

Mixing terminals

A voice paging network may be connected freely with terminals that do not use the voice feature. Voice terminals that connect to non-voice terminals can be programmed to block voice pages from passing to the non-voice terminals. Thus, the voice part of the network does not interfere with a non-voice network with which it is interconnected.

Network failures

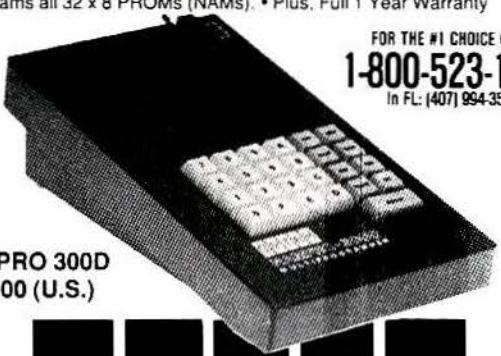
Because the voice paging on a TNPP network is coordinated by terminals at each end, a break in the network causes the loss of communication with these terminals. When such a break occurs, terminals on either side of the break assume the coordination activity. The single network becomes two independently operating networks.

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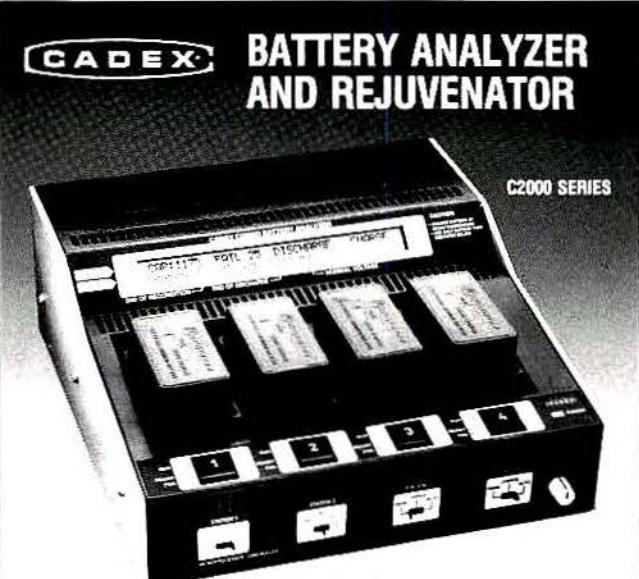


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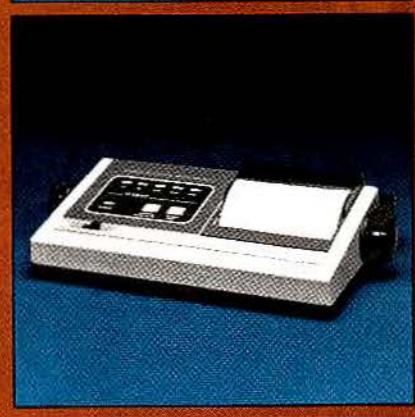
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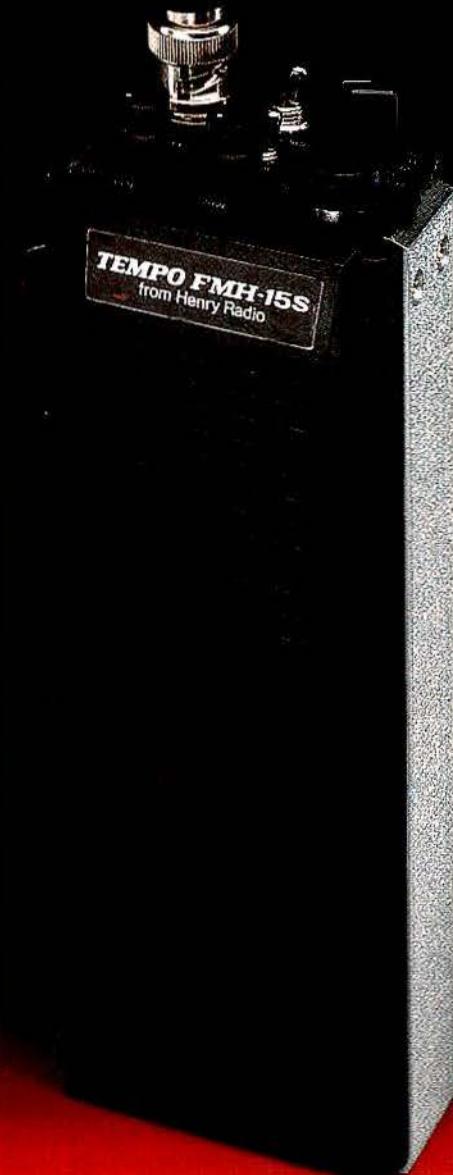
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terminals on either side of the break resumes, they relinquish control and the full network re-establishes itself.

Efficiency sacrifice

Voice paging on a network is inefficient. Any non-voice paging message passes much faster. The network can handle much more non-voice traffic.

But the United States has more medium-to-small systems than it has large systems. Smaller systems must sell voice paging service to build a profitable subscriber base. Airtime on such systems is abundant, so voice messages do not load them excessively.

Networking smaller systems for display-only paging is not practical until a sufficient volume of paging traffic is passed. In contrast, voice paging often makes the network not only practical, but profitable.

Other network uses

TNPP allows trunks to be concentrated in foreign exchanges and networked to the terminal connected directly

Voice message transmission

The voice message transmission procedure takes time. It involves:

- informing one or more terminals that a voice call is being transmitted to them.
- allocating a voice storage recorder at each terminal.
- waiting for an acknowledgement from each terminal that a recorder is available.

to the appropriate paging transmitter for wide-area coverage. Multiple foreign exchange lines may be replaced with a single network line—a substantial cost savings. Used in this way, trunk concentrators are actually networked paging terminals that may not be connected to paging transmitters.

As with the trunk concentrator, multiple transmit lines that serve an area may be replaced with a single network line and paging-only terminals with no input trunks can be used to control multiple channels and transmitter zones.

Conclusion

TNPP has proven to be a reliable medium for the exchange of information between terminals. Networks are easy to implement, and the connections between nodes has proven to be quite versatile. Voice paging adds a capability that allows the medium-to-small paging system operator to participate in the rapidly expanding wide-area paging market.



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Q U I N T R O N

Performance testing for base remote controls

Use off-the-shelf test equipment, along with some equipment and accessories you build, to test and measure base station remote control system performance. Records you create will help with troubleshooting.

By Harold Kinley, CET

Remote control line problems probably cause more frustration to land mobile radio technicians than any other single problem.

• First, the problem must be isolated, either to the line itself or to equipment connected at the opposite end.

If the line is defective, the telephone company (telco) must fix it. But do not turn the problem over to the telco prematurely. If the line is not the problem, the telco probably will charge you for the time spent checking.

I have been involved in troubleshooting a remote control line that passes through a rural area and *two* telephone companies' jurisdictions. Now, there was a *real* finger-pointing contest! I hope you will not be as unlucky.

• Second, remote control lines can be long, and it seems as though the problem always lies at the opposite end. Because of the distance involved, it is much easier to isolate the problem if you and another technician work on it together, one at each end of the line. A coordinated effort requires direct communications—telephone or radio contact. Then you can run *cause and effect* tests to isolate the problem.

• Third, many technicians do not have adequate test equipment to analyze or to set up remote control systems properly. Those who do are fortunate because the old "whistle" and multimeter (with limited decibel range) technique is ill-suited for the task.

• Fourth, adjusting remote system audio levels often is confusing and arbitrary—more of an art than a science. A



Remote control line problems must be isolated, either to the line itself or to equipment connected at the opposite end.

technician twiddles with the level-setting adjustments until his partner yells,

"Sounds good! Nail it down right there!" So he does. A little more science and a little less art pays off when it comes to remote control system adjustments.

Console audio tests

Almost all remote control consoles use a *compression amplifier*. The compression amplifier *should* operate in both transmit and receive modes. Its purpose is to maintain a nearly constant output despite wide variations in input signal level.

Normally, you should set the input signal (from the mic for transmit or the audio line for receive) to the compression curve's "knee." The knee is the point beyond which further input signal increases cause little output increase.

Too much compression (setting the input level too high) brings up background noise during pauses in speech. Too little compression (setting the input level too low) results in "blasting" with higher input levels.

The remote control console's line input/output impedance is *600Ω balanced*. Test equipment connected to the line terminals also should have a *600Ω balanced* impedance. Connecting *unbalanced* test equipment introduces hum that may interfere with the desired measurement. This information applies to testing the remote control console; testing the remote control (telephone) line will be discussed later.

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. His book is *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

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Scientific calculator keystrokes

dBm/voltage conversions (600Ω)

(A) To convert dBm (in 600Ω) to voltage across 600Ω, enter:

dBm $\begin{array}{|c|} \hline +/ - \\ \hline \end{array}$ $\begin{array}{|c|} \hline \div \\ \hline \end{array}$ 20 $\begin{array}{|c|} \hline = \\ \hline \end{array}$ $\begin{array}{|c|} \hline \text{INV} \\ \hline \end{array}$ $\begin{array}{|c|} \hline \text{LOG} \\ \hline \end{array}$ $\begin{array}{|c|} \hline \div \\ \hline \end{array}$ 1.29 $\begin{array}{|c|} \hline = \\ \hline \end{array}$ <READOUT>

Note: Use the $+/-$ key only if the dBm value is negative.

Example: The audio level on a 600Ω line is -5dBm. Convert this dBm value to the rms voltage across the line.

Solution: Enter:

5 $\begin{array}{|c|} \hline +/ - \\ \hline \end{array}$ $\begin{array}{|c|} \hline \div \\ \hline \end{array}$ 20 $\begin{array}{|c|} \hline = \\ \hline \end{array}$ $\begin{array}{|c|} \hline \text{INV} \\ \hline \end{array}$ $\begin{array}{|c|} \hline \text{LOG} \\ \hline \end{array}$ $\begin{array}{|c|} \hline \div \\ \hline \end{array}$ 1.29 $\begin{array}{|c|} \hline = \\ \hline \end{array}$ <0.077529379>

(B) To convert rms voltage (across 600Ω) to dBm, enter:

E $\begin{array}{|c|} \hline \div \\ \hline \end{array}$.775 $\begin{array}{|c|} \hline = \\ \hline \end{array}$ $\begin{array}{|c|} \hline \text{LOG} \\ \hline \end{array}$ $\begin{array}{|c|} \hline \times \\ \hline \end{array}$ 20 $\begin{array}{|c|} \hline = \\ \hline \end{array}$ <READOUT>

Example: The rms voltage across a 600Ω line is 1.5V. What is the dBm level?

Solution: Enter:

1.5 $\begin{array}{|c|} \hline \div \\ \hline \end{array}$.775 $\begin{array}{|c|} \hline = \\ \hline \end{array}$ $\begin{array}{|c|} \hline \text{LOG} \\ \hline \end{array}$ $\begin{array}{|c|} \hline \times \\ \hline \end{array}$ 20 $\begin{array}{|c|} \hline = \\ \hline \end{array}$ <5.735791131>

□ **Compression threshold**—Manufacturers' service manuals usually specify two minimum signal input levels required to reach the compression threshold: one for *receive*, one for *transmit*.

For example, a typical compression threshold sensitivity might be listed on the transmit specification chart as 100mV and on the receive specification chart as -20dBm. Use the following equation to convert dBm (at 600Ω) to volts:

Voltage (at 600Ω)

$$= (10^{(dBm/20)})/1.29 \quad (1)$$

To convert voltage (at 600Ω) to dBm, use this equation:

dBm (at 600Ω)

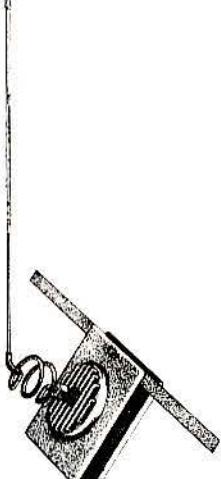
$$= 20 \log (E/0.775)$$

Refer to the box at the left for scientific calculator keystrokes to use in mak-

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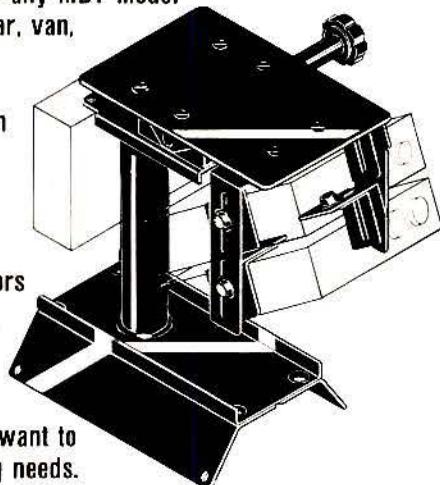
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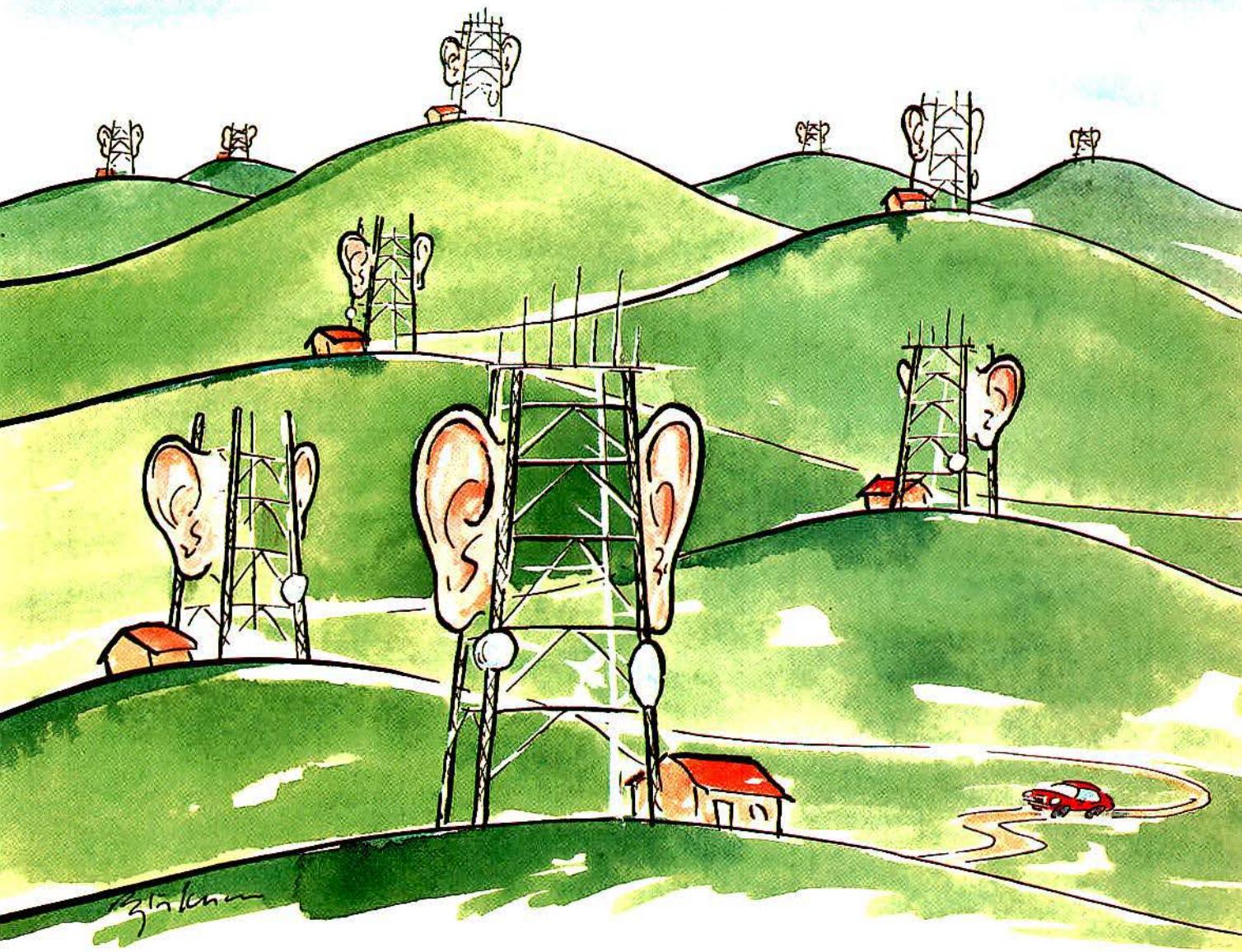
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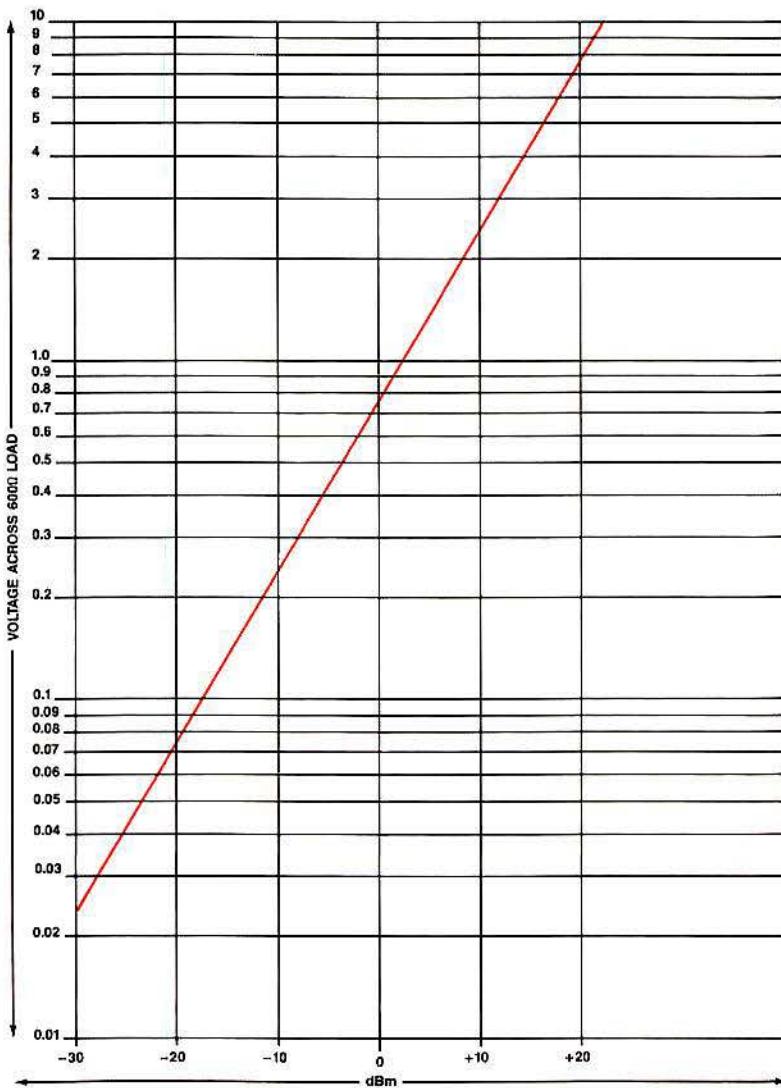


Figure 1. Use this graph to convert between dBm and rms voltage in 600Ω lines.

ing the conversions. You also may use the graph in Figure 1 above to convert dBm to voltage at 600Ω .

Compression performance—The

specification chart usually states the compression performance clearly.

For example, "With an audio input increase of 30dB beyond compression threshold, the output level will increase

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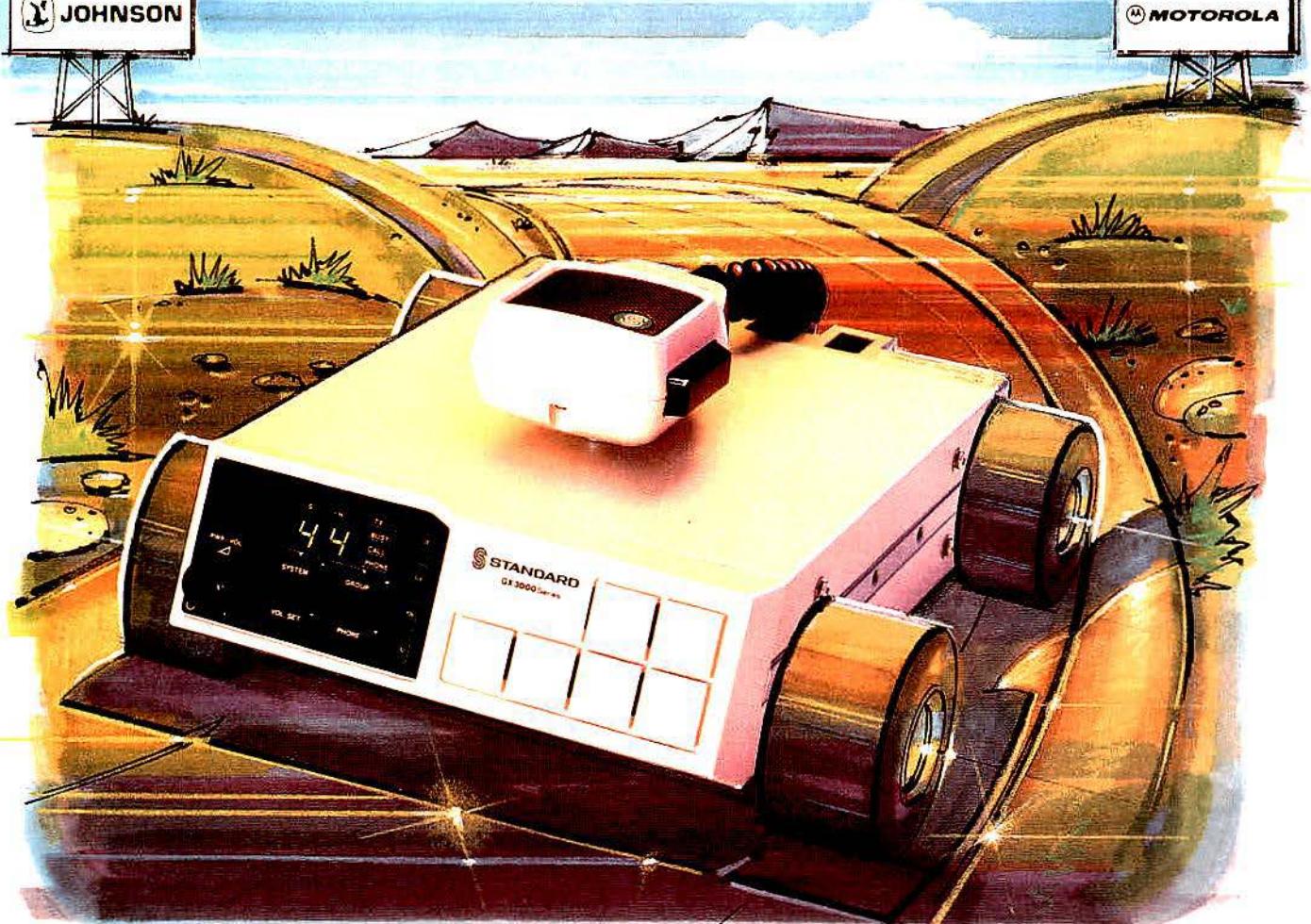
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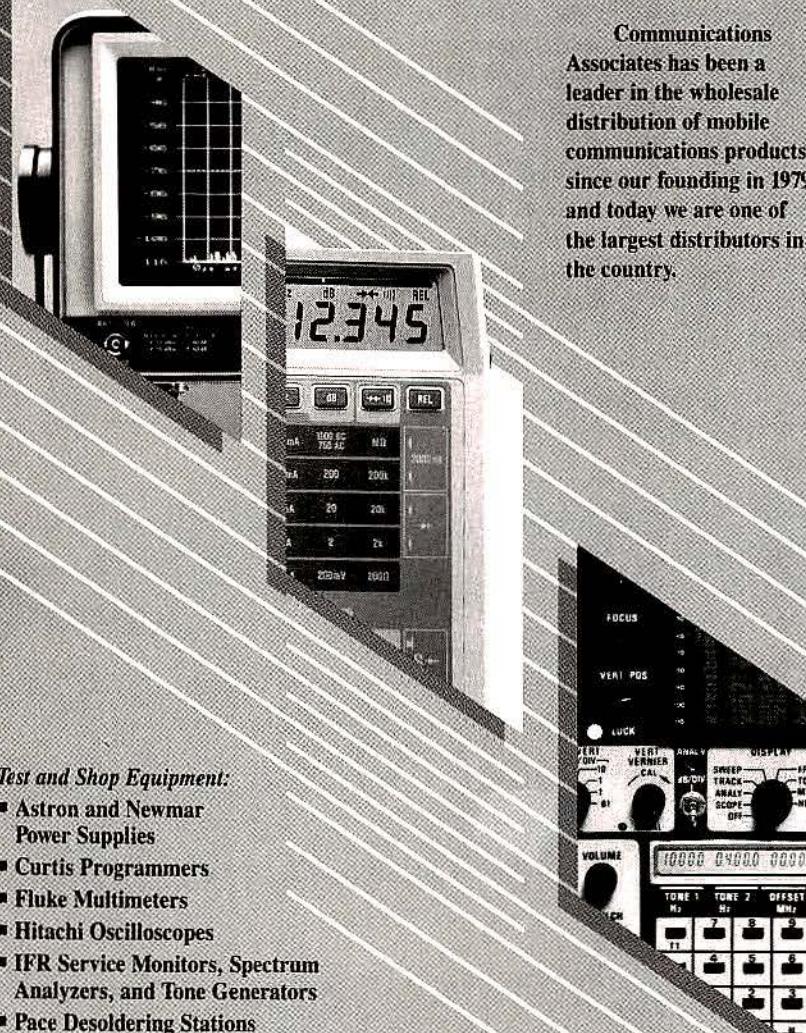
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com switch instead of the *transmit* switch during the test, no keying voltage is placed on the line, but the audio output is the same.

If the audio meter/distortion analyzer has a 600Ω *balanced* input, you may omit T_1 .

Suppose the transmit-mode specification for output level/distortion is "less than 5% distortion @ 20dBm @ 30dB compression." If the compression threshold is 100mVrms at the mic input terminals (mic *level* control set to maximum), set the audio generator output level to 100mV *plus* 30dB, which equals 3.16Vrms. Then set the remote console's *line output* control to produce exactly 20dBm or 7.75Vrms at the output. Measure the distortion. It should be equal to or less than 5%.

Measure the receive-mode audio output/distortion in a similar fashion. But remember to measure the audio output/distortion level across the speaker terminals with the proper audio input signal applied across the line terminals.

Signal-to-noise ratio—The procedure used to measure the transmit-mode signal-to-noise ratio resembles the procedure used to measure the output level/distortion figure. Refer once again to Figure 2.

Set the audio generator to 1kHz at a level well above the compression threshold. Adjust the *line output* control in the remote console to produce the *rated* dBm output level as measured on the audio dBm meter. This is the 0dB reference.

Next, remove the 1kHz input signal from the *mic input* and record the residual noise level read by the audio dBm meter. The difference between the two readings in decibels is the signal-to-noise ratio.

Measure the receive-mode signal-to-noise ratio in a similar way, remembering to take the measurement across the speaker terminals with the audio input signal applied across the line terminals.

Remote control line testing

The first order of business is to determine whether a remote control problem lies in the leased control line or in equipment connected to the opposite end.

If the leased line is at fault, the repair responsibility rests with the telco. Be-

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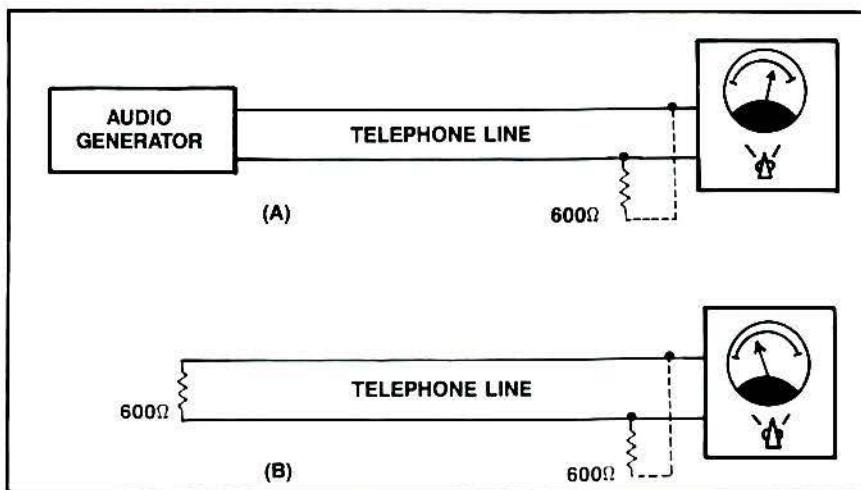


Figure 3. Use this test setup to make simple telephone line tests. At (A), an audio generator set to 0dBm checks line loss at various frequencies. The setup at (B) measures noise level.

fore calling telco, you should perform certain control line tests to be sure the trouble indeed lies with the leased line and not in the remote console or termination equipment.

The following information should

help you to isolate the problem. The specified test procedure required depends on the kind of remote control trouble. If you are testing the line upon initial installation, you may want to run all of the tests to give the line a "clean

bill of health." The tests require direct communications with another technician at the opposite end of the line.

Attenuation/frequency response tests—Set up the test equipment as shown in Figure 3 at the left.

You need a balanced audio generator output. If it is not balanced, connect a line-to-line telephone transformer between the generator output and the telephone line.

If the dBm meter does not have a built-in 600Ω termination, connect a 600Ω resistor across the line at the measurement end. The nearest standard EIA resistor size, 620Ω, is acceptable.

An example of a suitable test instrument is shown in Photo 1 on page 56.

Set the audio generator frequency to 1,000Hz. Adjust the generator output level to 0dBm (0.775Vrms) at the telephone line input. *Do not feed a tone level in excess of 0dBm into the line.* Ask the technician at the opposite end to measure and record the dBm level. The

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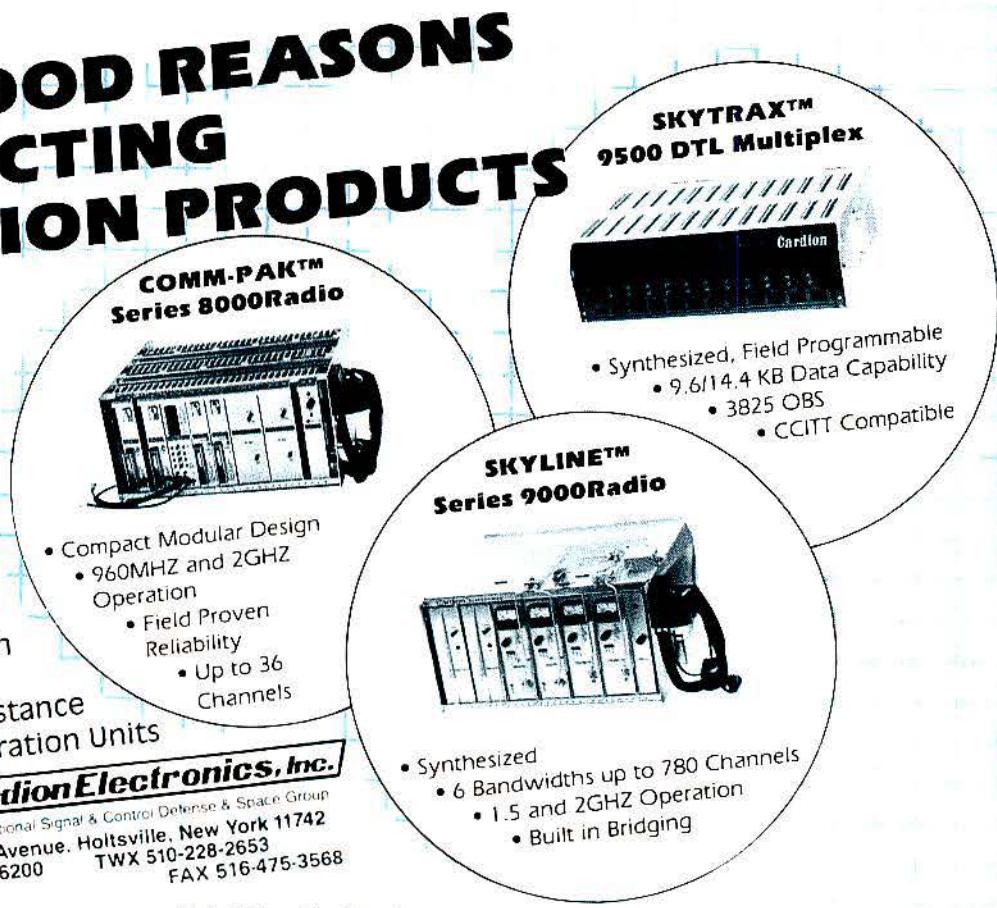
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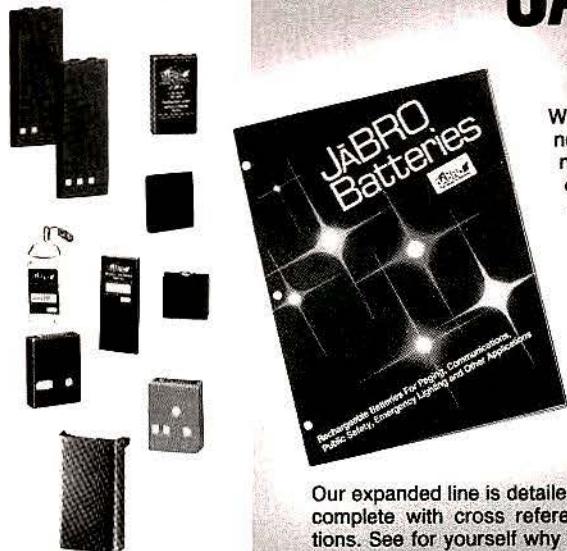


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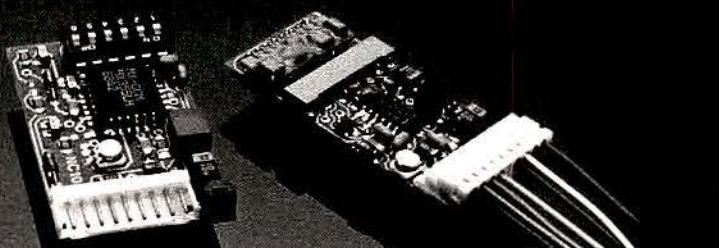
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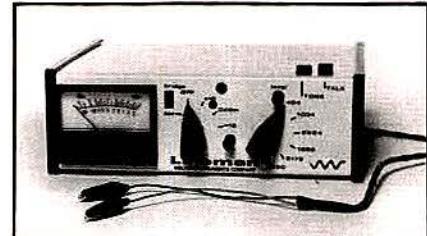


Photo 1. The Helper Instruments Lineman is an example of test equipment suitable for making attenuation/frequency response tests.

dBm reading equals the line attenuation in decibels at 1,000Hz.

For example, with a 0dBm signal applied at the sending end and a reading of -10dBm measured at the opposite end, the line loss is 10dB.

To get an idea of the line's frequency response, use at least three discrete test frequencies. This method is called the *three-point response test*. The test frequencies are 400Hz, 1,000Hz and 2,800Hz. The telco may use 404Hz, 1,004Hz and 2,804Hz.

Run the test for each frequency the same way you ran the 1,000Hz attenuation/frequency response test. Use the 1,000Hz measurement as the 0dB reference.

For example, if your measurements are

- -5dBm at 1,000Hz,
- -8dBm at 400Hz and
- -10dBm at 2,800Hz,

the 400Hz tone is said to be *3dB down* and the 2,800Hz tone is said to be *5dB down*.

Generally, the line's bandwidth is defined as the frequency range in which loss at the minimum and maximum frequencies falls 10dB; this is called the 10dB bandwidth. Frequency-selective attenuation can cause fairly sharp notches to appear in the frequency response measured at the opposite end.

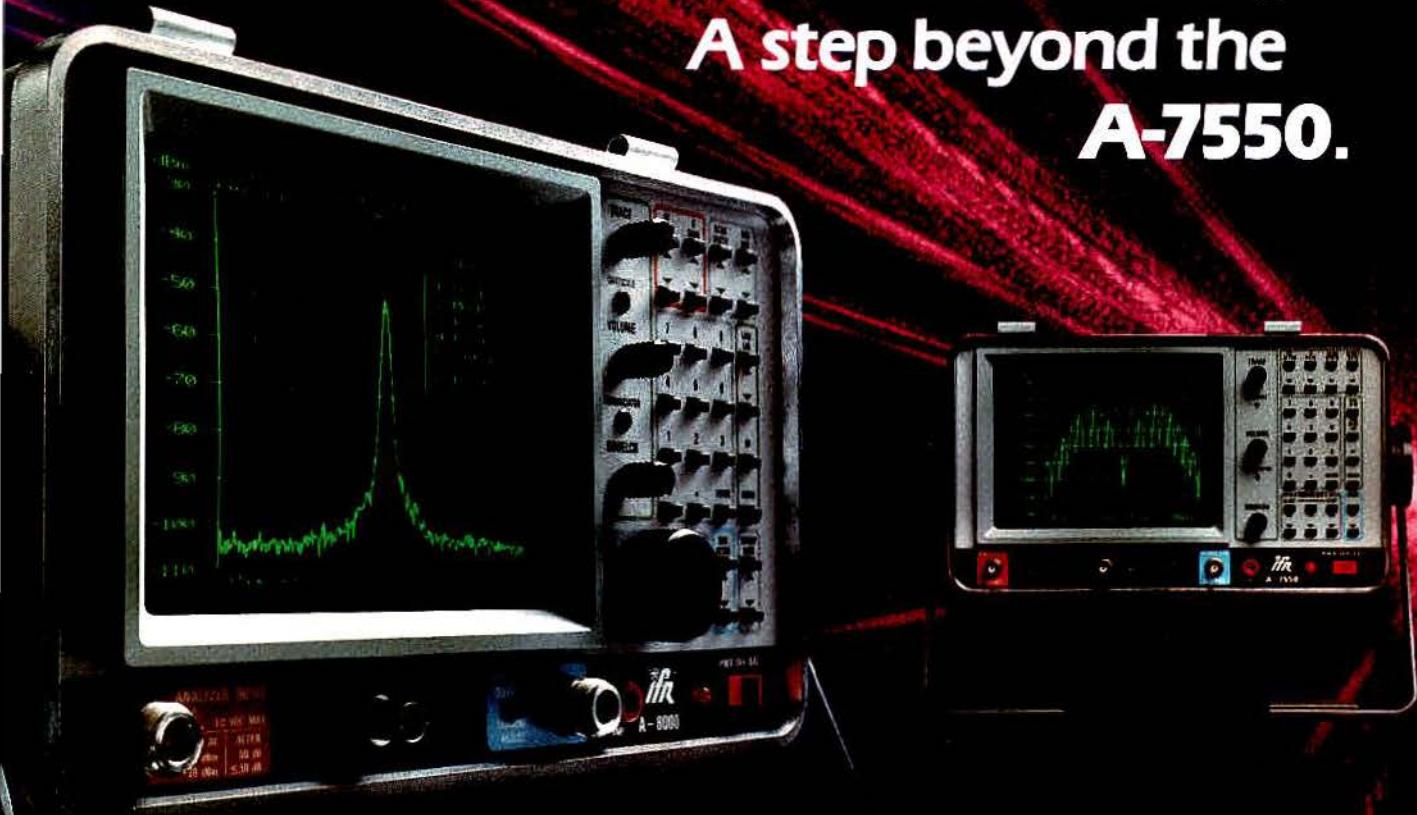
Notches may or may not cause problems. If a tone remote system is used and one of the notches occurs near one of the control frequencies, then it may cause a problem. On the other hand, if the remote control is a dc system, a notch may have no detrimental effect.

When tone remote control is used, it is a good idea to run a response test at each tone frequency used by the system, in addition to the three-point response test.

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frequency response test, if time permits. You must closely coordinate the test with the technician at the opposite end.

Slowly tune the audio generator from 300Hz to 3,000Hz. Keep the output level constant. Call out the frequency at various increments for the benefit of the technician at the opposite end.

The technician at the opposite end should record the specific increments, as well as any sharp drops or rises between the increments. Use the results to make a chart or draw a graph of the frequency response.

Signal-to-noise ratio—Undesired noise signals approaching the levels of desired signals can degrade the quality of the desired signals seriously. The detrimental effect of noise on a telephone line to some extent can be overcome by increasing the line input signal level.

But the telco imposes a limit to the signal level on leased lines because extremely "hot" signals may cause severe crosstalk and interfere with other cir-

cuits. Generally, technicians set the line level as high as the local telco practice permits (and unfortunately, sometimes higher) in order to maintain a high signal-to-noise ratio.

Noise measurements may be made with a flat response or a weighted response. Only *in-band* noise harms the system—noise within the 300Hz to 3,000Hz range. Noise signals outside this range may be ignored. For this reason, the telco usually measures noise through a special filter called a *C-message* filter. Measurements made with a flat response (without the filter) indicate a higher noise level because a wider range of frequencies is measured. It follows that a flat-response noise measurement does not assess the noise situation fairly. Noise above 2kHz will contribute to signal degradation if the response of the remote equipment extends considerably higher than 3kHz. Check equipment specifications to be sure.

Nevertheless, if a test instrument with

a C-message noise filter is unavailable, the flat-response noise measurement must do.

Use the test setup shown in Figure 3B on page 54 to make the noise measurement. Simply read the noise level on the dBm meter and record it. If the instrument has a C-message filter, switch it in. Make a notation to indicate whether the noise measurement was taken with or without a C-message filter.

Use the response measurements you made in the attenuation/frequency response tests to determine the signal-to-noise ratio.

For example, if the noise level measures -50dBm and a tone frequency of 2,000Hz was recorded at -10dBm , the signal-to-noise ratio at 2,000Hz is

$$-10 - (-50) = -10 + 50 = 40\text{dB}$$

Because some control tones in tone remote systems are sent at a rather low level, it is imperative that noise be kept to a minimum. Otherwise these low-level tones may be lost in the noise. If you speak with telco employees about noise measurements, be sure to say whether the noise was measured with a C-message filter or with a flat response.

Excessive hum may occur on the line if it becomes unbalanced. To check whether the line has become unbalanced, disconnect it at both ends and check the line-to-ground resistance on each leg of the line. The resistance should be extremely high (infinity is the ideal reading), and the reading should be the same for both legs.

Dc-line measurements—Leased control lines are classified as *metallic* or *non-metallic*.

Dc remote control systems use metallic lines. They provide dc continuity from one end to the other.

Tone remote control systems use non-metallic lines. They do not provide dc continuity.

Metallic lines must carry dc to perform control functions. Line polarity must be observed.

If the line's *loop resistance* is too high, control functions may be impaired. The best time to make your first loop resistance measurement is when the line is installed. If that opportunity is missed, it still is a good idea to make and record the measurement.

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That's just one of the features that distinguish Philips as the world's paging leader. The PG32N numeric model has a 125-character capacity with a large liquid crystal display of up to 10 bold numbers at a time. The PG32A Alphanumeric pager features up to nine memories with a 512-upper and lower case character capacity.

And both feature rapid stored message access, scrolling of selected messages, eight-address capability, urgent and voice message indications, automatic call deletion, 19 easily understood information flags, and long battery life with low battery indication.

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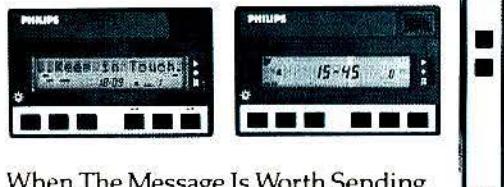
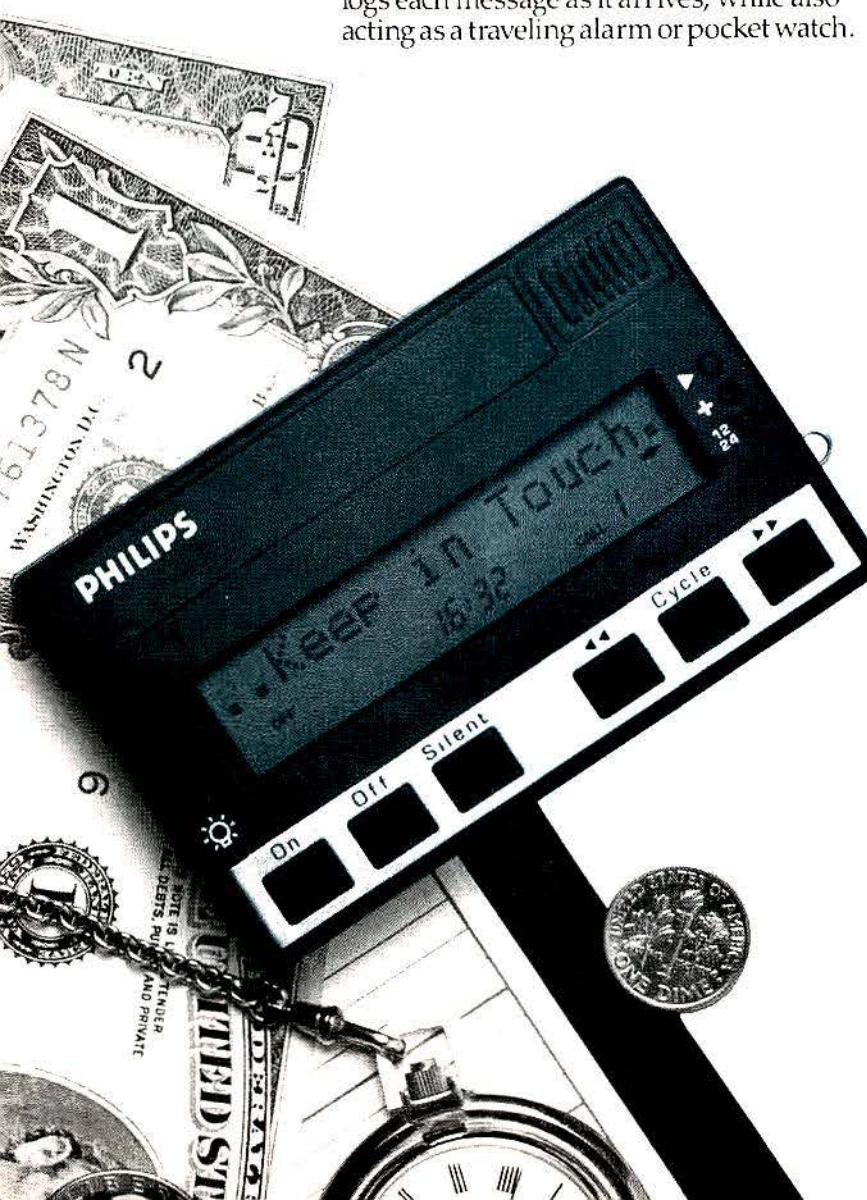
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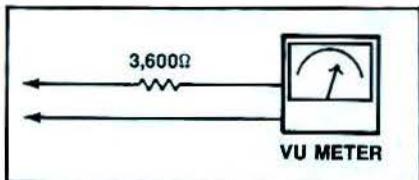


Figure 4. This is the simplest possible volume unit (VU) meter circuit. Its sensitivity is +4VU.

Simply disconnect the line at both ends, connect the legs together at one end and measure the resistance between them at the other end. Post the reading for future reference.

There are several audio level adjustments in the remote system that must be set for optimum performance *without exceeding maximum line levels established by the telco*. I highly recommend you read "What Techs Need to Know About Telco Line Testing" by John A. McNeill, USN-Ret., which was pub-

lished in the April 1986 issue, for more information on the subject.

According to McNeill, some remote control manufacturers' manuals may recommend level-settings that exceed telco limits. But the telco must share blame for confusion about maximum line-level limits.

When a line is leased for remote control purposes, the telco should provide (and you as the lessee should demand) written specifications for the line. The specifications should include the maximum signal level, tone and speech, that can be applied to the line.

□ *Speech levels vs. tone levels*—Constant-tone signals usually are measured with an audio meter called a *dBm meter*. The definition of 0dBm is 1mW power fed to a 600Ω load (0.775V across 600Ω).

Speech signals are measured in *vol-*

ume units (VU) with a special instrument called a *VU meter*. The VU meter was developed about 1940 through coordinated efforts of Bell Laboratories and major radio broadcasting networks. The meter has special, *standardized* ballistic characteristics that control factors including rise-time and overshoot.

Although there is no way to convert volume units to dBm for speech signals, a 0dBm tone produces a 0VU reading on a VU meter. The VU meter never is connected directly across a line. It must be connected through an attenuator/matching network.

The simplest possible VU meter circuit is shown in Figure 4 at the top left. The circuit's sensitivity is +4VU.

Figure 5 below shows a schematic for a simple VU meter you can build. This circuit offers several advantages over the simple circuit of Figure 4.

First, the two blocking capacitors,

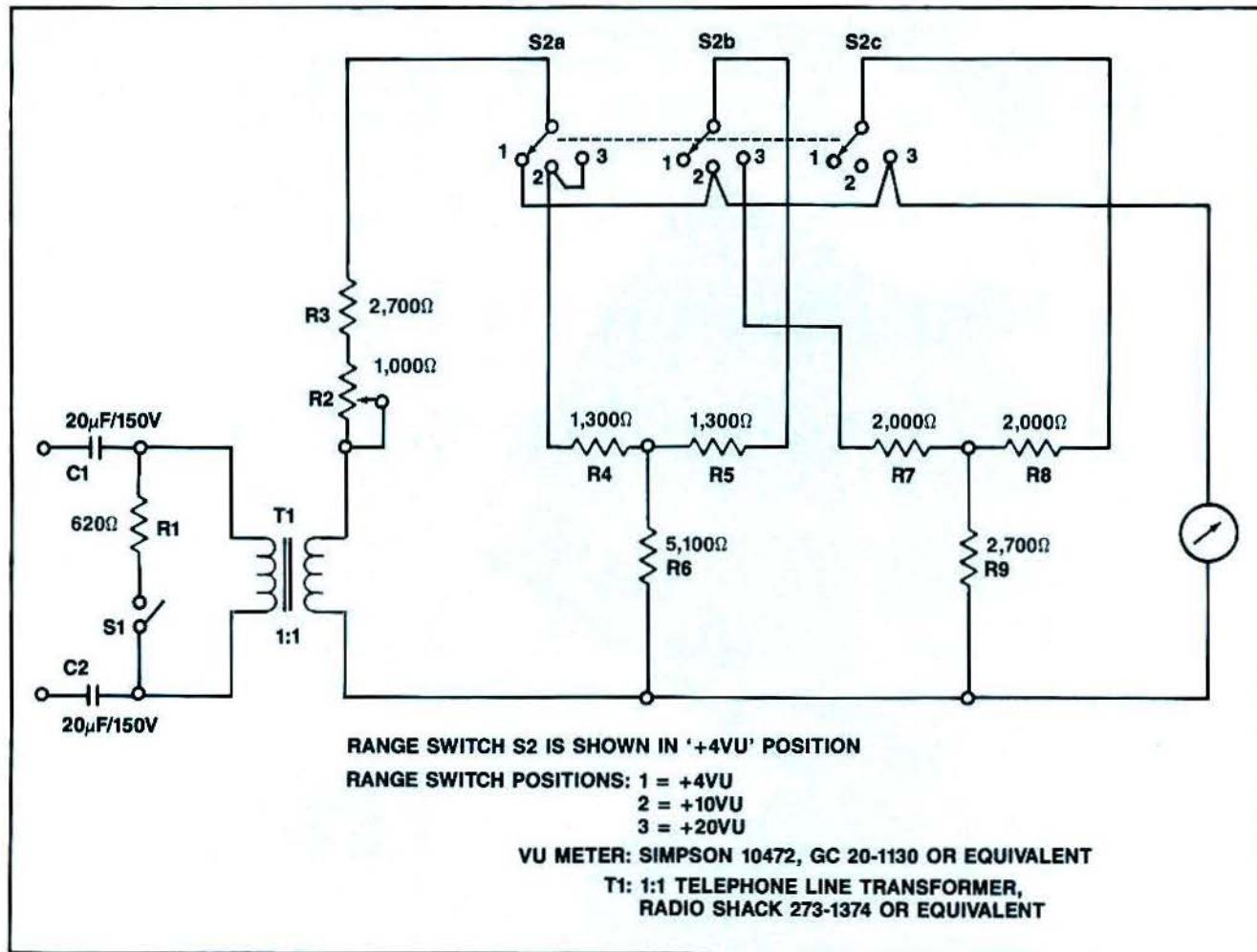


Figure 5. This volume unit (VU) meter circuit is easy to build, and is handy for checking speech levels on telephone lines.

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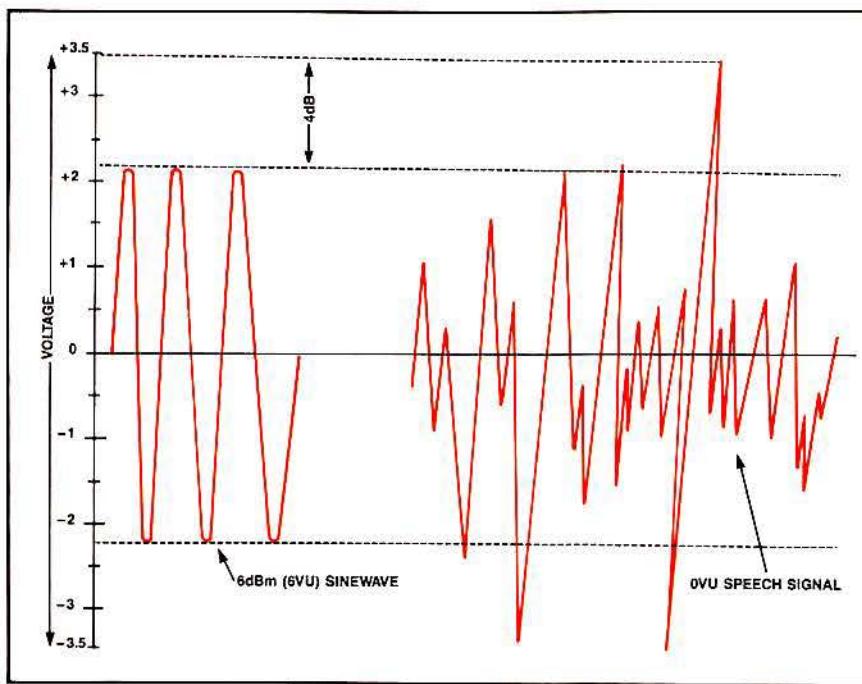


Figure 6. A comparison of a 0dBm sinewave and a 0VU speech wave. Notice that occasional speech wave peaks exceed the sinewave's peaks by as much as 10dB.

along with the line transformer, allow you to use the instrument on control lines in the presence of keying voltage. If you never will use the instrument on lines in the presence of dc voltage, you may omit the line transformer and two blocking capacitors.

A load resistor (R_L) can be switched into the circuit to provide termination if needed. When the circuit bridges a line, the resistor is switched out.

Second, two range-multiplying attenuator networks are provided to increase the normal +4VU range to +10VU or +20VU.

You can build the instrument into a small utility box by using point-to-point wiring.

To calibrate the instrument, switch the load resistor R_L , set the range switch to +4VU, and apply a 0dBm, 1.000Hz tone to the input. Adjust R2 for a reading of -4VU on the meter.

Figure 6 at the left shows a comparison of a 0VU speech signal and a 0dBm tone signal. Notice that occasional peaks

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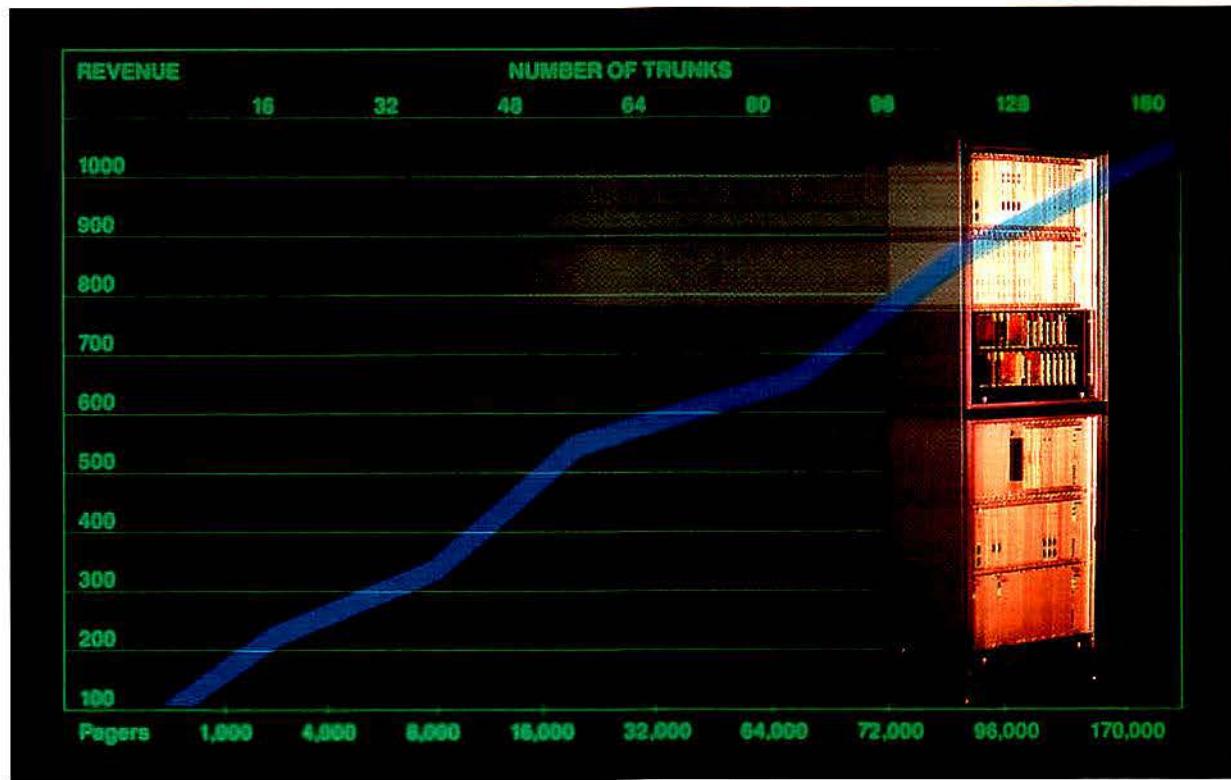
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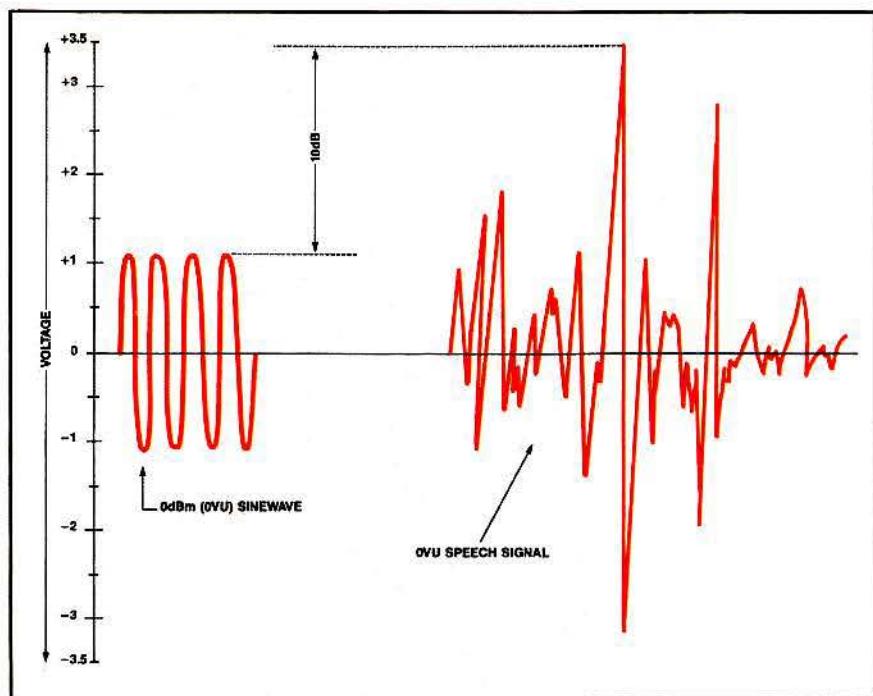


Figure 7. A comparison of a 6dBm compressed sinewave and a 0VU compressed speech wave. Because the compressor-amplifier action is not instantaneous, some of the sharp peaks exceed the compressed level by a few decibels.

of a 0VU speech signal may exceed the peaks of a 0dBm tone signal by as much as 10dB. This does *not* mean that a 0VU speech signal will produce power equivalent to a 0dBm tone signal. The average power in a 0VU speech signal is less than the average power in a 0dBm tone signal, even though the instantaneous peaks in the speech signal have much higher power.

Figure 7 at the left shows a comparison of a 6dBm compressed tone signal and a 0VU compressed speech signal. The majority of speech signal peaks are approximately equal to the peak level of the 6dBm signal. But occasional speech signal peaks exceed tone signal peaks by as much as 4dB. Thus, insofar as the peak levels are concerned, a 6dBm compressed tone signal is approximately equivalent to a 0VU compressed speech signal. For purposes of comparing peak-level signals, it is reasonable to say that a compressed speech signal of 0VU is approximately equivalent to a compressed tone signal of $(X + 6)$ dBm.

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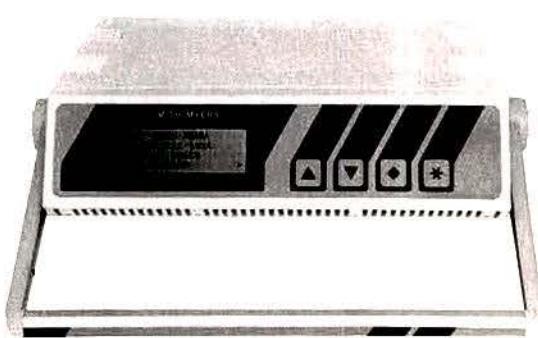
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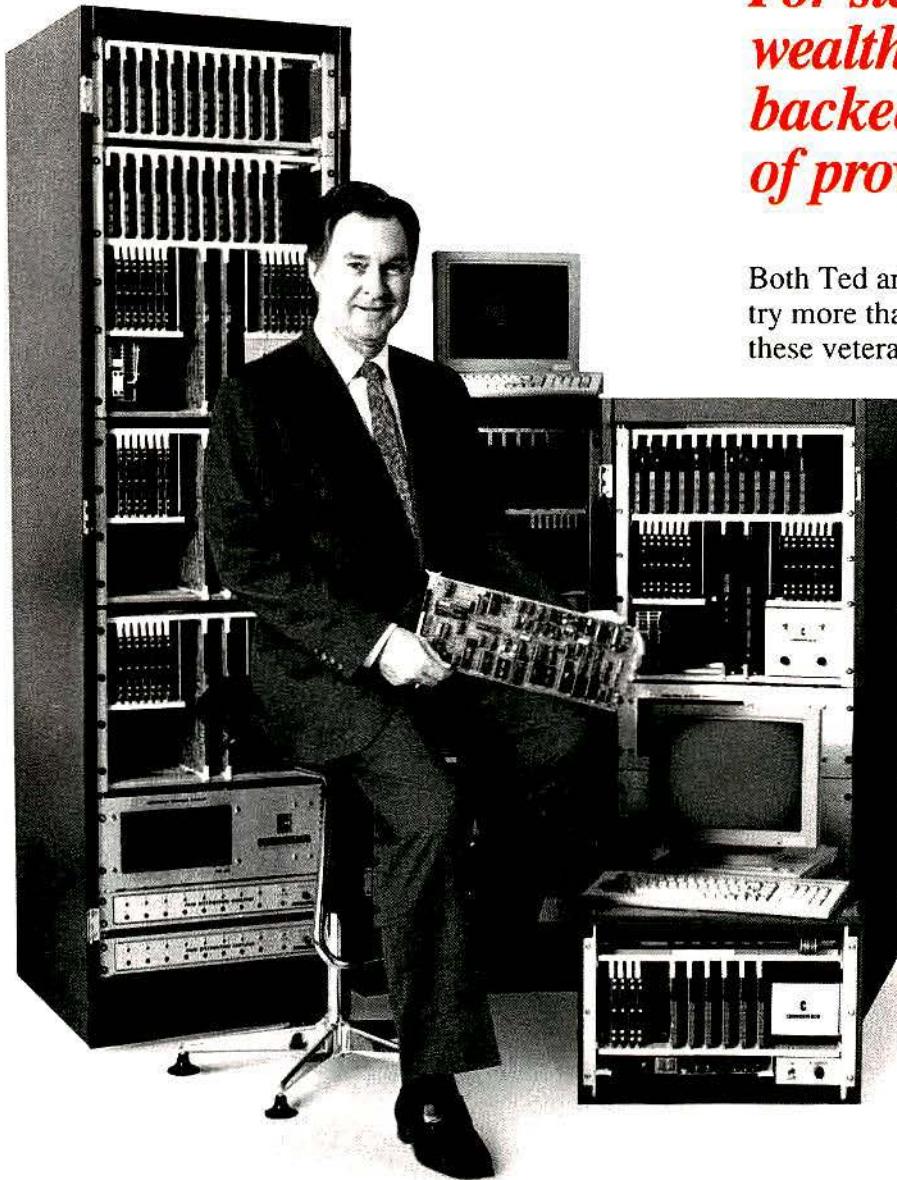


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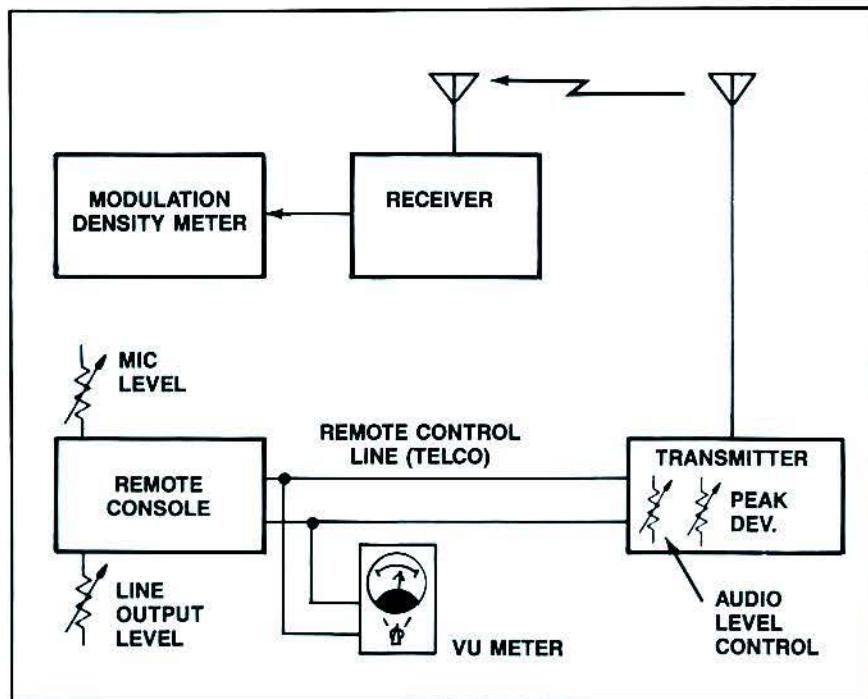


Figure 8. Use the VU meter and the modulation density meter in this test setup to make final level settings for the *transmit mode*.

□ *Level-setting techniques*—The previous information implies that, for test purposes, an equivalent-dBm compressed tone signal may be substituted for a specified VU compressed speech signal.

For example, suppose the telco limits the maximum line input to +8VU compressed speech signal. The equivalent dBm compressed tone signal is $8 + 6 = 14\text{dBm}$.

But telco regulations generally forbid applying *tone* signals of this magnitude to the leased line. How do you get around this? Here are two approaches:

(1) Because the equivalent dBm tone level applied directly to the leased line exceeds telco limits, the most obvious approach is to use a VU meter to set the *speech* level applied to the leased line at either end.

Figure 8 at the left shows a test setup in which a VU meter and a *modulation density* meter are used to make the final *transmit mode* audio level adjustments. The modulation density meter is shown



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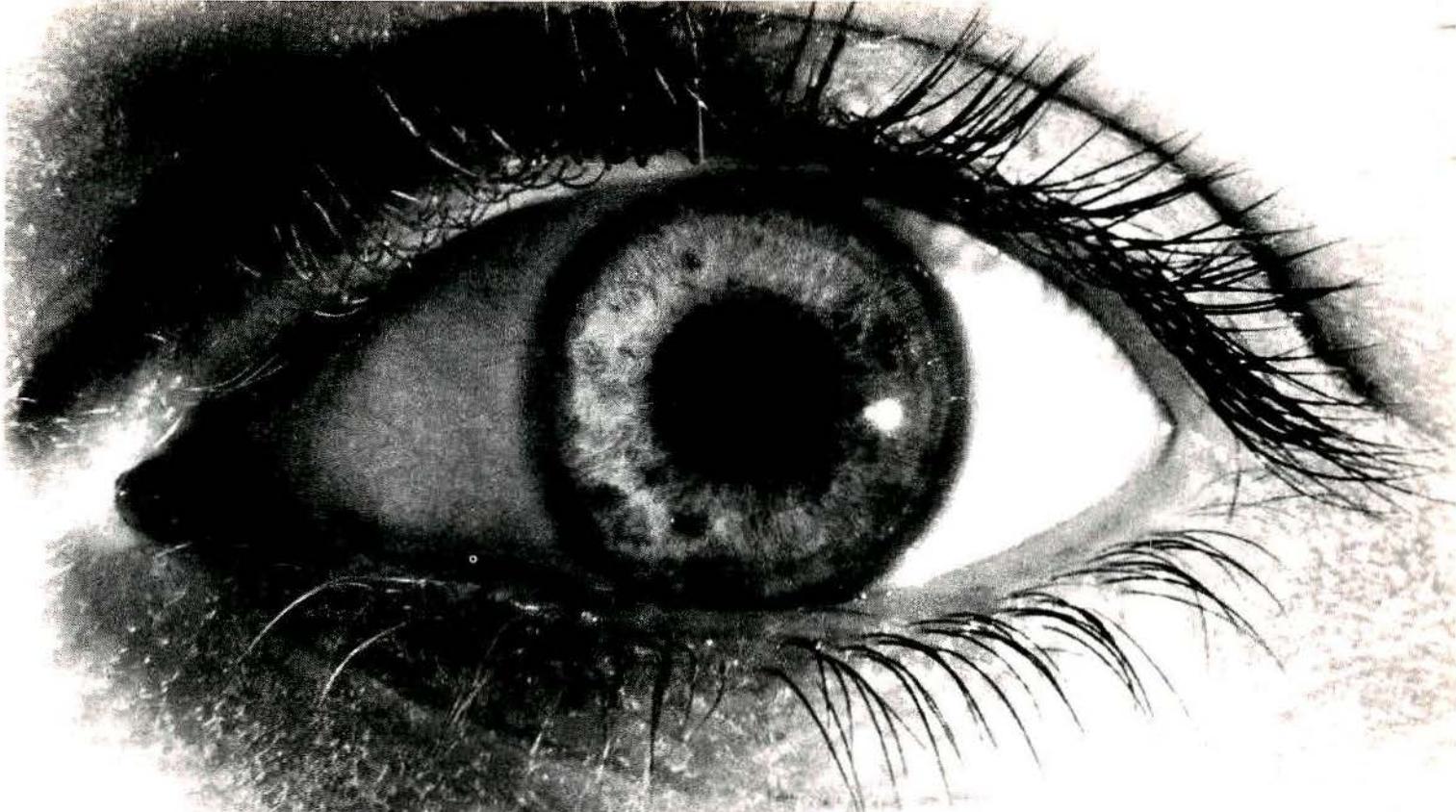
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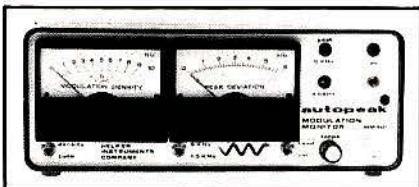


Photo 2. The Helper Instruments Autopeak is an example of a modulation monitor with a modulation density meter. The modulation density meter is most helpful in setting speech signals for the proper amount of compression and limiting. This makes the signal 'sound' good.

in Photo 2 above. (It would be useful if the modulation density measurement unit were adopted as a *standard*, just as the volume unit was adopted as a standard about 1940.)

Too much compression at the remote console or too much limiting at the transmitter shows up as an excessive modulation density reading. Insufficient compression or limiting shows up as a low reading. Adjust the remote console output level to produce the proper VU meter reading.

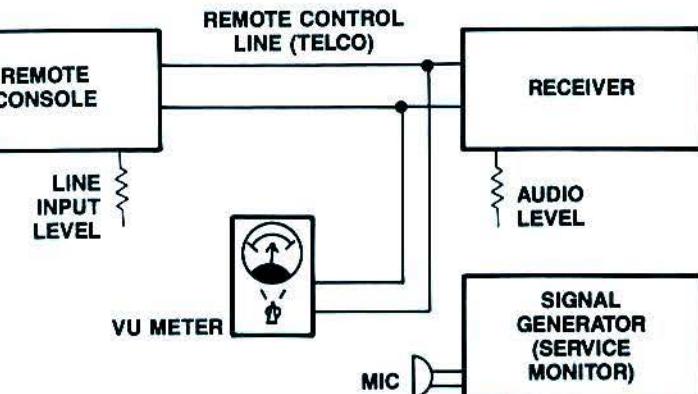


Figure 9. Use this test setup to adjust the receiver audio level into the telephone line.

For example, if the maximum specified line level is +8VU, switch the VU meter to the +10VU range and adjust the output to produce a reading near -2VU on frequent voice peaks. Occasional peaks may exceed -2VU.

If the VU meter peaks high on every syllable, the compression is too great;

reduce it.

Make final adjustments to the *mic level* control on the remote console and the *audio level* control on the transmitter as you monitor modulation density with the meter.

Figure 9 shows the test setup for using the VU meter to set the *receive mode*

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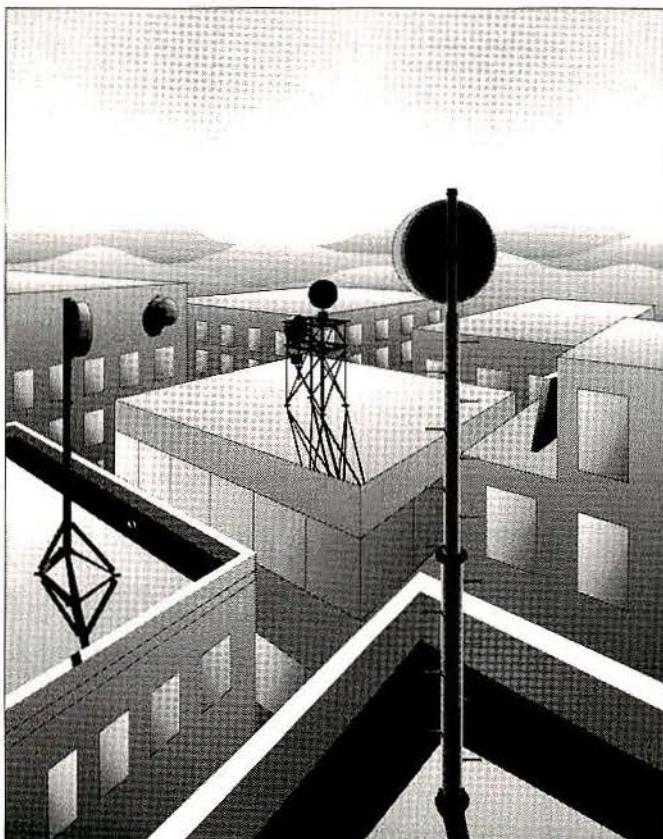
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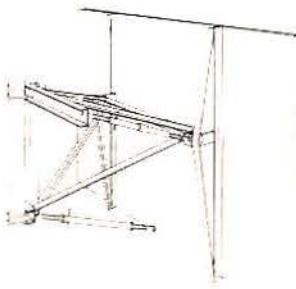
Tripods: As with monopoles, aesthetics are often a consideration for the selection of tripods. These structures are designed for roof mounting and are engineered for 100 mph (40 psf) winds. Five models are available ranging from 6' to 20' in height.

Standoff Wall Mounts: Standoff Wall Mounts offer several advantages over regular wall mount units. They



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Wall Mounts: These units can be specified for corner mounting or flat



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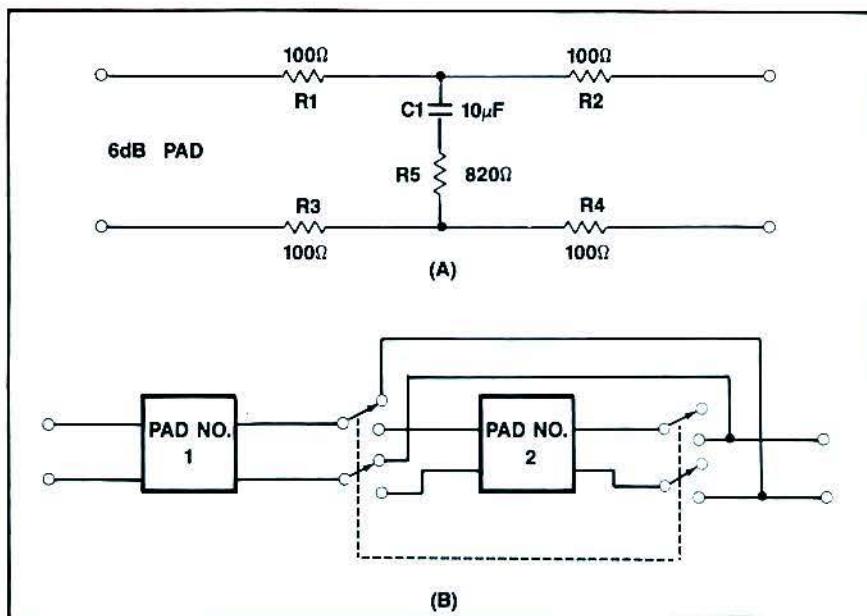


Figure 10. An H-pad, such as the one shown at (A), is useful in making certain telephone line tests and adjustments. If you will use the pad on a line with dc keying voltage, place the blocking capacitor in the leg.

The H-pad also is useful for determining the system's safety margin. The configuration at (B) shows how to connect two pads to provide different amounts of attenuation.

audio level into the line. While the signal generator is modulated by speech at full system peak deviation, adjust the receiver audio level control to produce the proper VU speech level into the leased line. Then adjust the *line input* control on the remote console to produce proper input to the compressor amplifier.

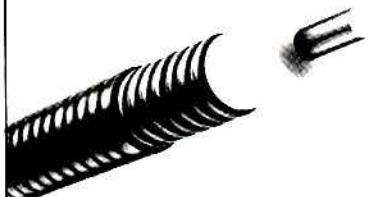
(2) Under typical conditions, you should not apply tone levels in excess of 0dBm to leased telephone lines. If the specified telco limit is +8VU for speech signals, you should not apply a +14dBm tone to the line.

Balanced H-pad

But there is a simple method that delivers results equivalent to feeding a higher-level tone into the line without actually doing so, thereby keeping within telco limits. It involves using a *balanced H-pad* such as the one shown in Figure 10A at the left. Capacitor C1 blocks dc keying voltage (for a dc remote). It does not noticeably alter pad attenuation at 1.000Hz.

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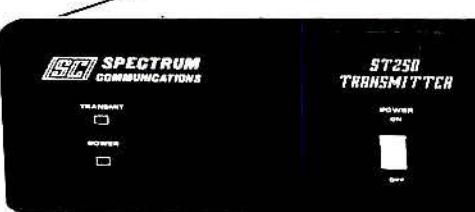
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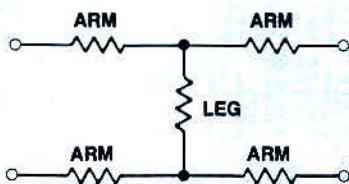
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H-PAD DESIGN CHART

dB LOSS	ARM (Ω)	LEG (Ω)
3	51	1,800
4	68	1,200
5	82	1,000
6	100	820
7	110	680
8	130	560
9	150	470
10	160	430

Figure 11. This chart shows how to construct H-pads with attenuation values from 3dB to 10dB.

Two such H-pads can be connected together as shown in Figure 10B to provide two attenuation values. With the switch in one position, the attenuation is equal to only the attenuation of Pad No. 1. With the switch in the other position, the total attenuation is equal to the attenuation of Pad No. 1 plus Pad No. 2.

Figure 11 above shows the proper resistor values to use in building H-pads for attenuation values from 3dB to 10dB.

Base station performance testing

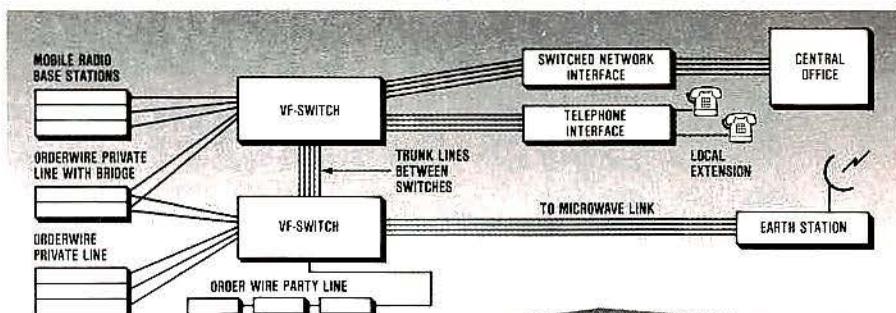
This article deals with base station remote control performance testing. Although not every possible test procedure is presented, those of greatest interest to the land mobile technician are described, along with information about how to analyze the results.

Related articles appear in previous issues:

"Performance Testing For Base Transmitters," appears in the January 1988 issue.

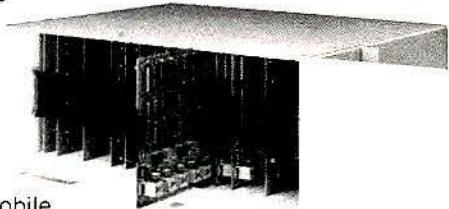
"Performance Testing For Base Receivers" appears in the November 1988 issue.

"Base Station Feedline Performance Testing" appears in the April 1989 issue.



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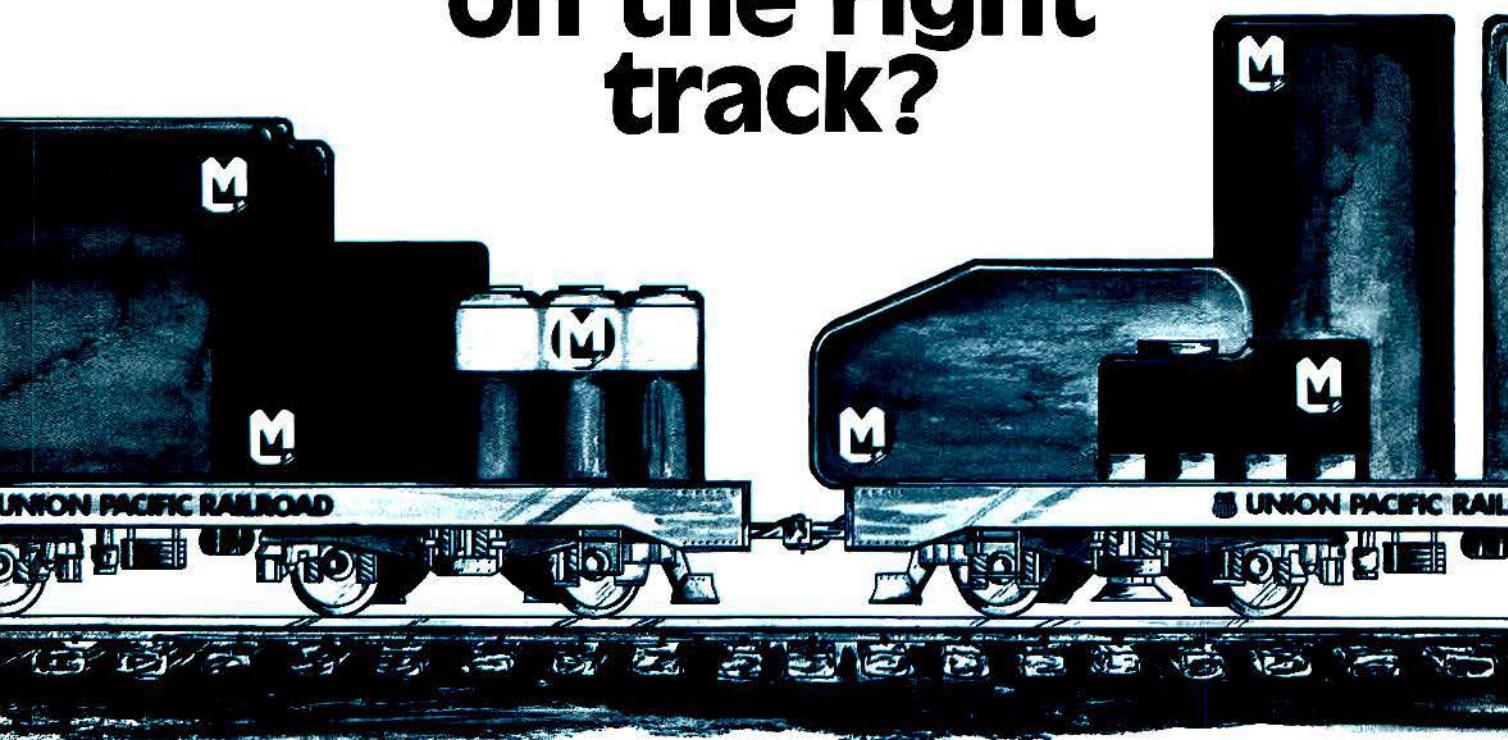
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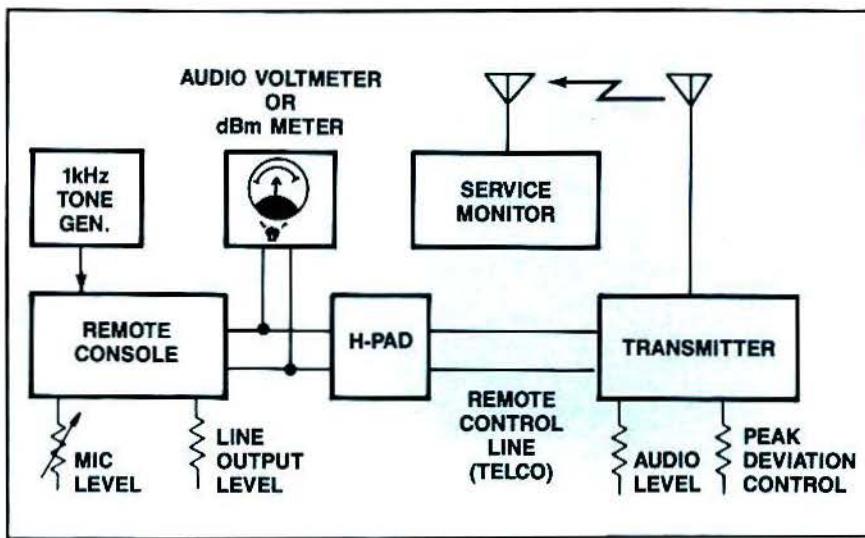


Figure 12. Use this test setup with an H-pad and a high-level test tone to set audio levels in the transmit mode.

Include a blocking capacitor in the *leg* if the pad is to be used on dc remote systems.

Figure 12 above shows how to connect the H-pad temporarily into the line to

set audio levels with a high-level 1.000Hz tone. The following example explains the procedure:

Assume that the maximum level permitted by the telco is +8VU compressed

speech level. This means the equivalent dBm compressed tone level at the remote console output is +14dBm. Yet, 0dBm should not be exceeded at the leased line input.

Connect a 14dB H-pad between the remote console line terminals and the leased line. The pad attenuates the +14dBm tone signal to 0dB at the line input.

Set the 1.000Hz tone generator to a level several decibels above the compression threshold. Then set the *line output* control to produce +14dBm at the console line terminals (the H-pad input).

Set the transmitter's *audio level* control to produce an exciter input level 14dB *below* the level prescribed in the manufacturer's manual. (The level will increase by 14dB when you remove the H-pad.)

Adjust the *mic level* control according to the instruction manual. Generally, this adjustment uses a specified 1.000Hz input level to adjust the mic level control so the signal at the compressor is

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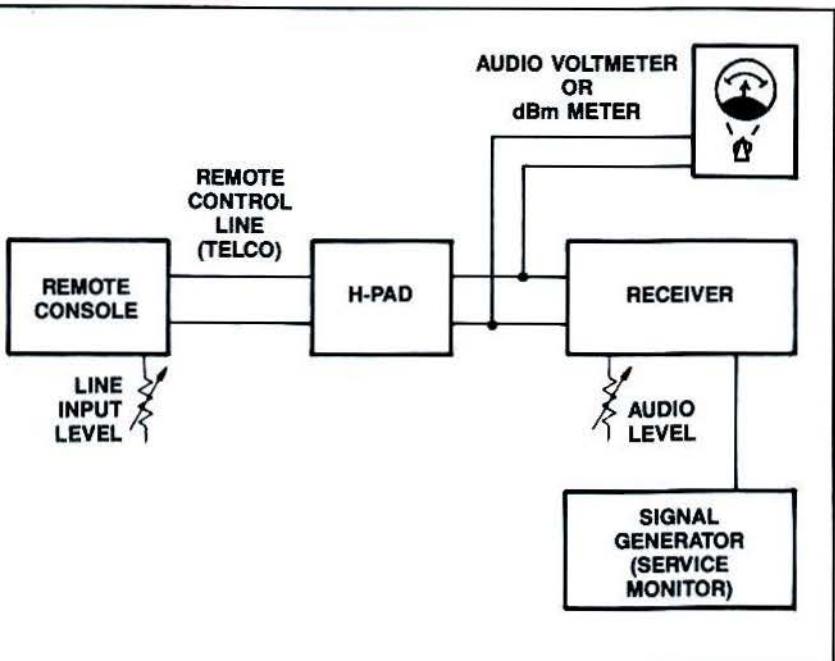


Figure 13. Use this test setup with an H-pad and a high-level test tone to set audio levels in the receive mode.

at the compression threshold or "knee of compression."

Figure 13 at the left shows the procedure for setting the input to the line at the base station end. With a 1,000Hz tone, modulate the signal generator to full system deviation. Adjust the receiver audio level to produce +14dBm at the line terminals (H-pad input). Then set the *line input* control to a level 14dB *below* the level prescribed in the manual.

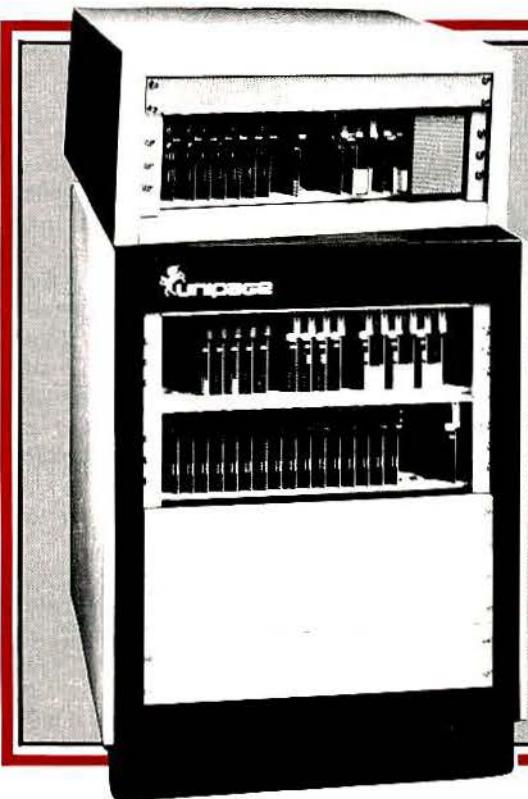
Remove the H-pad when the level-setting adjustments are complete. 

References

1. Bernstein, Julian L., *Audio Systems*, John Wiley & Sons, New York, 1966.
2. "Pinpointing Phone Line Problems," *Remote System Techniques #4*, Industrial Electronics Service, Schaumburg, IL, 1983.
3. Kaufman, Milton, and Arthur H. Seidman, *Handbook of Electronic Calculations for Engineers and Technicians*, McGraw-Hill, New York, 1979.
4. McNeill, John A., "What Techs Need to Know About Telco Line Testing," *Mobile Radio Technology*, April 1986.



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Lightning prevention test stirs competitive spirits

Methods used by the Federal Aviation Administration (FAA) to test lightning prevention equipment have come under fire by the Washington, DC-based Coalition Against Non-Effective Lightning Protection Technologies (CAN'T). But the FAA test, conducted under the

supervision of Edwin Harris, the agency's associate administrator for development and logistics, has been endorsed by a distributor of one of the devices being tested.

The FAA is testing the Verda lightning deterrent unit and Lightning Eliminators

and Consultants' Dissipation Array dissipative system at airports in Tampa and Orlando, FL. The units represent a group of products intended to reduce or prevent lightning strikes by dissipating ions from multipointed metal terminals elevated into the air.

The tests have been challenged by Joseph Foley, executive director of CAN'T, which was formed by manufacturers of products designed to safeguard equipment from lightning damage through the use of grounding and isolation techniques. Foley has asserted that the lightning prevention devices have not been tested adequately by a recognized private-sector organization or in an appropriate federal laboratory environment. He also said that members of the coalition dispute the FAA's testing method, which includes connecting the lightning prevention devices to conventional lightning protection systems already in place. "Either someone at the FAA has concluded that a lightning bolt should be grounded if, in fact, a dissipative-type system cannot prevent lightning or there is some confusion at the agency regarding acceptable scientific method," he said.

Donald F. Hudalla, president of Lightning Deterrent, a Chicago-based distributor of the Verda unit, defended the FAA tests. "Why do you suppose the FAA is conducting these tests?" he asked. "It is precisely because conventional lightning protection systems have not been effective in protecting against extensive and expensive damage from lightning strikes."

Hudalla asserted that "lightning rods attract lightning and hope to channel it safely to the ground. This doesn't always succeed. To the contrary, the Verda point discharge system acts to deter the lightning strike. The presence or absence of conventional lightning protection is immaterial. In fact, in our installation of the Verda units, we remove any existing lightning rods."

Hudalla said the FAA is adhering to scientific method. But no information has been offered by Harris, Foley or Hudalla to describe what method, scientific or otherwise, is used for the tests.

"We challenge CAN'T to find a private-sector organization that can test

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the Verda lightning deterrent unit," Hudalla said. "We would eagerly submit the Verda unit for testing by that laboratory, if it exists."

"We submit that the finest, if not the only, laboratories for testing the effectiveness of lightning dissipation equipment are precisely the airport radio control towers being used by the FAA at Tampa and Orlando," Hudalla said.

Periphex enters market with portable batteries

Periphex has sold private-label nicad replacement batteries through distributors for two years. In addition to its private label program, the company has launched a direct sales effort.

"Most of our batteries have short-circuit protection," said Erwin Phillip, sales vice president. "Short-circuit protection prevents a battery from causing accidental fires or burns if, for example, keys or coins carried in a pocket with a battery short the battery contacts, causing high current to flow and producing heat," he explained.

Phillip said Periphex batteries use high-capacity cells whose capacities and internal resistances are matched within a tolerance of 0.3%. The result is greater battery capacity. "We always try to put a higher-capacity battery in the same physical size or equivalent size. In actual use, you get more hours per charge."

Periphex makes batteries to fit handheld transceivers made by Motorola, GE, ICOM, Kenwood, RCA, Maxon, Henry Radio, Wilson, Yaesu and Ritron.

The company was founded six years ago by Phil Jacobs to design computer hardware. That portion of the business continues, and Jacobs devotes the bulk of his time to it.

The battery-making operation occupies several thousand square feet of an office and manufacturing facility at 149 Palmer Road, Southbury, CT 06488; 203-264-3985.

Telocator partakes in paging industry survey

Telocator, a trade association of paging and mobile telephone system operators based in Washington, DC, and Economic and Management Consultants

International (EMCI), Arlington, VA, are undertaking a major survey of the paging industry. The survey covers industry growth and service trends in 1988 and expectations for 1989.

The survey addresses the number of pagers and paging transmitters in service, percentage of pagers in service by type and average annual inventory levels.

Telocator plans to discuss its findings at its spring convention, May 3-5 in Orlando, FL. Further surveys are planned for the middle of this year to measure activity in the first half of 1989. 

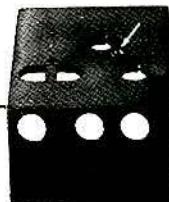
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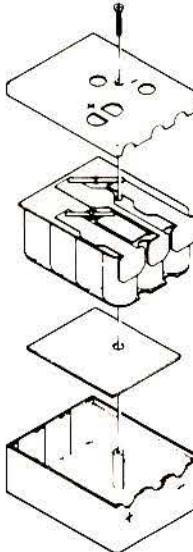
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12,000 renew 'grandfather' certificates

Aug. 31 is the expiration date for NABER "grandfather" certificates, and already more than 12,000 have been renewed. At the inception of its certification program, NABER offered grandfather certificates to everyone who already held an FCC license at a grade higher than Third Class without requir-

ing the applicants to pass an examination. By late 1984, 32,000 grandfather certificates were issued, after which they were unavailable. New grandfather certificates no longer are available, but existing certificates can be renewed.

With the August expiration date, all grandfather certificates now will expire

at the same time. The fee to extend the grandfather certification for five more years is \$22.

Technicians who have not received a certificate renewal application, should notify the Technical Services offices at 800-759-0300. Those who allow their current certification to expire without renewal will be required to pass the NABER certification exam to requalify. Individuals who have renewed their certificates should allow eight weeks for processing.

Those technicians who do not hold NABER certification but wish to be certified by NABER must pass NABER's exam. Technicians should contact NABER for examination dates.

Test questions sampling

The following are sample test questions. Use these questions to test your knowledge.

- 1) A correct statement regarding receiver desensitization is that it:
 - A. is caused normally by spurious frequencies generated internally.
 - B. can be prevented often by careful grounding techniques.
 - C. is only a problem in mountaintop repeater sites.
 - D. can sometimes be minimized through the use of tuned cavities.

- 2) A wattmeter reads 60W when placed in an ac circuit. An ammeter in the circuit reads 0.66A, and the voltmeter reads 110V. The power factor is:
 - A. 0.27
 - B. 0.45
 - C. 0.663
 - D. 0.82

- 3) The licensee is required to retain station records for:
 - A. Six months
 - B. One year
 - C. Two years
 - D. Three years

- 4) A customer wants a radio to be adjusted so that the power output is above the legal limit.
 - A. The power output can be set above

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the legal limit if the IF gain is decreased.

B. This should not be done under any circumstance.

C. This can be done legally if the customer pays an additional fee.

D. The power cannot be set above the legal maximum, but the deviation

meter measures useful power; therefore, the power factor for this problem is 60 divided by the quantity, 0.66×110 .

3) Letter B is correct. These station records must contain a description of any maintenance that has been done to the station and also the measurements of transmitter frequency, power output and deviation. The name of the person

doing the work must be included. Refer to parts 90.443 and 90.447 of the FCC rules and regulations for more details. Note that the work station as defined by the FCC includes vehicular-mounted and portable radios.

4) Letter B is correct. Neither the power output nor the deviation can be set above the FCC specified limits under any circumstances.



The Association of Communications Technicians (ACT) is a membership section of the National Association of Business and Educational Radio (NABER).

amount can be set above the legal limit.

Answers

1) Letter D is correct. Receiver desensitization is caused by a strong signal changing the bias of one of the receiver stages. This bias change reduces the gain of the stage and, therefore, the receiver is less sensitive than it would be if the strong signal was not present.

The change in sensitivity can result in a marginal, but acceptable, signal becoming noisy and unintelligible. By using tuned cavities as a filter at the receiver input, the strong signal often can be filtered out without attenuating the desired weak signal.

Desensitization often occurs on mountaintop repeater sites because there are many strong signals present, but this is not the only place it is a problem. Poor grounding signals sometimes can allow desensitization to occur if the poor grounding results in less shielding on a filter system, but repairing the ground is not as common of a solution.

2) Letter D is correct. In a circuit in which the net reactance is zero, the voltage and current are in phase and the power dissipated in the current is voltage times current. That is, the circuit is resistive. But, in a circuit with net reactance, as well as resistance, there is a reactive power that surges back and forth but does no useful work. This reactive power increases the voltage and current values but does not add to the useful power.

Power factor is defined to be useful power divided by voltage times current. In a circuit with zero net reactance, the power factor is one. In a circuit with net reactance, it is less than one. A watt-

LOOKS ARE DECEIVING

The STI-CO Cellular/VHF Broadband Disguised Antennas.

Our innovative models deliver what appears to be ordinary 13-inch cellular antennas — but they cover the entire 150-174 MHz bandwidth, *without tuning!*

And, because they fit *all* cars they're conveniently stocked and easily installed either permanently, or as loaners.

In magnetic, roof, or trunk lip mount.

AND NOW — AVAILABLE IN UHF

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Two-Way Antennas

36 LETCHWORTH STREET / BUFFALO, NEW YORK 14213 / (716) 881-3287

Circle (81) on Fast Fact Card

FCC nixes standards for public safety trunking

One FCC notice of inquiry concludes as another opens, signaling the end of one round of debate for public safety trunking standards.

The FCC has closed its inquiry into whether the government should impose standard signaling for use with 800MHz

trunked public safety radio communications equipment made to use on 6MHz of spectrum in the 800MHz band released in June 1986. Comments submitted by the public to the regulatory agency during the inquiry revealed a consensus on only one issue: that the issuance of

licenses to use the new spectrum should not be slowed.

Responding to that consensus, the FCC opted to conclude its inquiry and to speed "expeditious licensing of public safety communications systems, upon the approval of the relevant regional plans."

In issuing another notice inquiry, the agency expects to explore spectrally efficient signaling technologies, such as digital signaling. Some form of standard conceived by the industry may emerge as result of the inquiry. So-called marketplace standards have been preferred by the commission, which has avoided imposing standards in recent years.

Radio association asks FCC to allow routine short-spacing

Approval of short-spaced specialized mobile radio (SMR) assignments would be handled on a routine basis if the FCC grants a request made by the American SMR Network Association (ASNA).

Currently, the FCC must process engineering documentation and grant waivers for each license application that specify a transmitter site within 70 miles of a co-channel licensee. Under the rule change requested by ASNA, letters of concurrence from each co-channel licensee to whose facility a new transmitter site is to be short-spaced would be sufficient.

NAACP asks regulators to restrict pager use

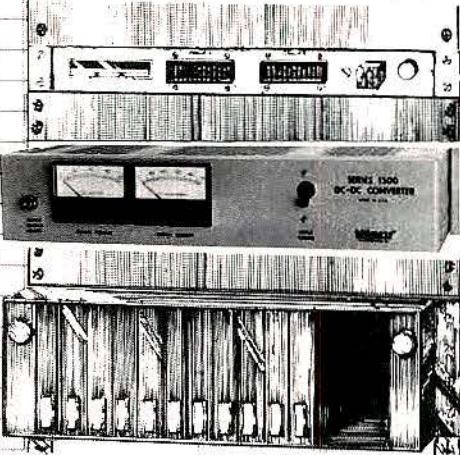
The National Association for the Advancement of Colored People (NAACP) has petitioned the FCC for stricter rules to govern the use of pagers. The object is to curb pagers' use in drug-related activities.

FCC will not require warning labels on scanners

The FCC has decided not to set a requirement for warning labels on scanning receivers. The labels would have warned users that it is against the law to listen to communications protected under the Electronic Communications Privacy Act. The commission had the proposal under consideration in a rulemaking proceeding.

DC-to-DC CONVERTERS FOR YOUR CELL SITES

- Available in 200, 400 and 800 watt models.
- 24V and 48V isolated outputs.
- 85% conversion efficiencies.



Cellular companies across the country use Wilmore converters to avoid the expense and maintenance of a second battery plant. Our proven reliability, competitive prices and quick delivery will combine to solve your DC-to-DC conversion problems.

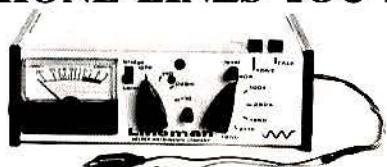
Wilmore ELECTRONICS CO., INC.

PO Box 1329, Hillsborough, NC 27278 • Telephone: (919) 732-9351

Designers and Manufacturers of solid state power converters since 1963

Circle (82) on Fast Fact Card

IF YOU WORK ON SYSTEMS WITH PHONE LINES YOU NEED A LINEMAN™



MODEL LM-106
CARRYING CASE

\$275.00
\$25.00

- Listen to the line or cable
- Communicate with the dispatcher/remote from the base station
- Measure line levels
- Measure tone remote control tone levels
- Measure line attenuation

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FAX: 407/777-1447

800-327-9308

TELEX 362837 (HELPER UD)

Circle (83) on Fast Fact Card

Product Preview

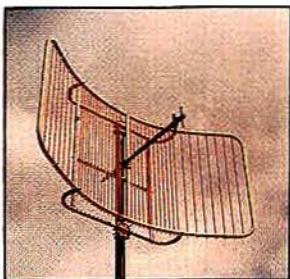


Dispatch Control

- User programmable.
- ANI.
- Status.
- Emergency status reporting.
- Selective calling unit, group or fleet by dispatcher.
- IBM PC compatible.
- Double handshake system.
- Encryption capability.
- Customized for user applications.
- Single- or multichannel capability.
- Disable units that are stolen or lost.
- Mark radios for special attention.

Transcrypt International

Circle (257) on Fast Fact Card



Scala Antennas

The PR-450U Paraflector is available with broadband feeds for both 800MHz and 900MHz trunking bands. Now you can enjoy the benefits of 17dB gain over those longer control paths where common yagis have provided only marginal performance.

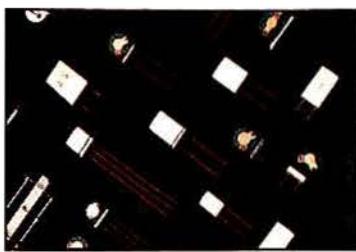
Circle (244) on Fast Fact Card



Ruggedized Portable

Bendix/King Mobile Communications Division's new line of ruggedized VHF portable radios meets specific methods and procedures of MIL-810C and D. The new MPH series has Bandtrac tuning: 148-174MHz coverage with no degradation in specifications! Built-in features include scan, priority scan, time-out timer, Codeguard squelch.

Circle (230) on Fast Fact Card



Quality Quartz Crystals

For more than 38 years, **International Crystal Manufacturing (ICM)** has manufactured quartz crystals and related frequency control products.

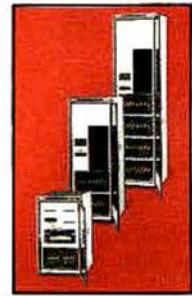
Circle (276) on Fast Fact Card



Replacement Batteries for Motorola Radios

Multiplier Industries announces 20 direct replacement batteries for Motorola radios: HT-50; HT-600; MT-1000 and MTX-800; STX; Radius P-10 and P-50; Radius P-100; and Radius P-200. Multiplier batteries are identical to original models in fit and appearance and meet or exceed original manufacturer's specifications. For catalog, call 800-642-2424.

Circle (241) on Fast Fact Card



SCE's PX Series Paging and Voice Messaging Systems

The PX series paging exchanges are advanced-technology, field-proven systems that expand easily from entry level to 200,000 subscribers, offering full paging support, built-in voice storage and retrieval, custom greetings, operator-assisted services, multilanguage voice. Call 516-822-9810 or 800-645-4357.

Circle (225) on Fast Fact Card



Riser-Bond Model 1210 Cable Fault Locator

Quickly and accurately measure cable lengths, conditions and faults with Riser Bond's Time Domain Reflectometer Cable Fault Locator. Test any coaxial, twisted pair or metallic pair cable for opens, shorts, impedance discontinuities, faulty connectors, water problems and system components. Unit's \$4,395 lists includes built-in scope and thermal printer. Call **Tessco**, 301-785-5300.

Circle (236) on Fast Fact Card



Maxon Synthesized Mobile Radio

Maxon Electronics introduces the SM-4150, a 40W, PLL synthesized VHF mobile radio with 16-channel capability, CTCSS and DCS signaling systems compatibility. A fast scan function includes dual-level priority scan — all controlled by the SM-4150's microprocessor. The unit has a die-cast aluminum chassis that is lightweight, yet extremely durable and simple to install.

Circle (234) on Fast Fact Card

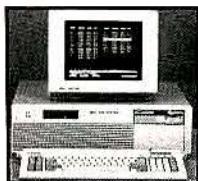


Cellular Look-Alike UHF Antenna

Sti-Co's disguised model appears to be a 13-inch cellular antenna, but is matched to exact UHF frequencies! Excellent in high cellular areas, as emergency spare and for most rented and leased cars. Fits most cars; easy installation as a permanent fixture or a loaner; trunk-lip mount; black/chrome; also available in VHF. Call 716-881-3287.

Circle (251) on Fast Fact Card

Product Preview



MDT Message Switch

- Terminal-to-terminal communication.
- Call dispatch.
- Status monitoring.
- Host computer inquiries.
- Report and statistics generation.
- Complete turnkey capability.
- Interface with any MDT terminal, packet radio controller, computer aided dispatch system, automatic vehicle locator.

Dealer inquiries welcome. Call **Hadron**, 703-359-6201.

Circle (264) on Fast Fact Card



Tone and Voice Pagers Require No Battery Charging

- operate 24 hours a day for months
- loud, clear audio message
- excellent paging sensitivity
- long-range, wide-area reception
- Reach, GE, EIA code formats
- internally generated alert tone
- rugged, durable, impact-resistant

Reach Electronics, Inc., orders: 800-445-0007; fax: 308-324-4985; Twx: 910-960-4741.

Circle (342) on Fast Fact Card



General Communications

Buy direct from the largest authorized General Electric dealer in the U.S.A.! Most prices below factory net—same-day shipment on all in-stock radios. MPI—PLS—MPD—MLS PSX200—Phoenix—Ranger—Delta Mastr II—TPX—TMX—MVS—MCS Visa, Mastercard 5157 Anton Drive accepted Madison, WI 53719 800-356-3200

Circle (235) on Fast Fact Card



Commonwealth Family Paging Terminals

The **Commonwealth** series of computerized paging terminals are full featured for the small to mid-size market. The Mark series continues development of new features and options, modular expansion, plus real value and 24-hour-a-day service.

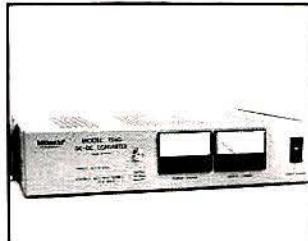
Circle (250) on Fast Fact Card



Model NC105 Digital Coded Squelch Encoder-Decoder

Model NC105 from **Norcomm** is designed specifically for squelch control applications and is compatible with both Motorola's DPL and General Electric's DCG systems. Featuring SMT microprocessor circuitry, more than 150 field programmable codes. It is 1.25" x 1.60" x 0.25". Price is \$84.95 (dealer net).

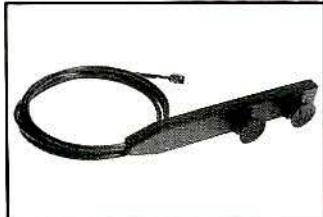
Circle (245) on Fast Fact Card



24V to 48V DC-DC Converter for Cell Sites

Model 1560 converter provides 16A at 48Vdc from 24V battery systems. Conservatively rated and 87% efficient, this converter allows more 48V power in less rack space (800W, 3 1/2 inches high). Availability is stock to four weeks. Contact **Wilmore Electronics**, 919-732-9351.

Circle (243) on Fast Fact Card



Modublox Cel-Gator

The Cel-Gator is a unique strip-line, high-technology antenna of uniform gain across both the wireline and non-wireline cellular bands with a maximum 1.3 VSWR. Designed for window mount for portables and transportables in auto, home or office. Available with TNC or mini-UHF connector and cable lengths of 5 feet or 15 feet.

Circle (246) on Fast Fact Card



Catalog/ Cross- Reference Disk

- Eight-page catalog featuring electron tubes (audio, transmitting, camera and CRTs), RF power semiconductors and modules, and CCTV equipment.

- Complete semiconductor cross-reference and pricing information for most two-way radios, including Motorola, General Electric, E. F. Johnson, Standard, Repco, Regency/Wilson, Aerotron, Quintron and RCA/Tactel on our PC disk.

Richardson Electronics
RF Gain Division

Circle (247) on Fast Fact Card



Modular Enclosures

Complete line of modular enclosures, equipment cabinets and custom enclosures available in virtually all shielding materials. Exclusive double-electrically isolated construction for maximum attenuation. All enclosures are fully tested and guaranteed. Application assistance available. **Lindgren R.F. Enclosures**, 400 Highgrove, Glendale Heights, IL 60139; 312-307-7200; Fax: 312-307-7571.

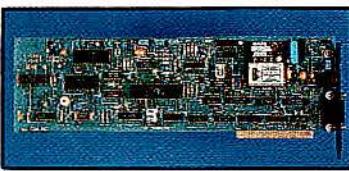
Circle (228) on Fast Fact Card



Land Mobile Catalog

A color catalog is available for the qualified land mobile professional. Featured is **Maxrad's** full line of mobile, portable and base station antennas, and mounts and accessories for two-way, cellular and radio telemetry applications. Call 800-323-9122.

Circle (271) on Fast Fact Card



Computer Card Radiopaging Terminal

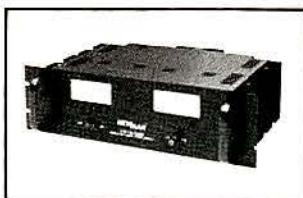
The MX P39 plugs into a personal computer to...

- Answer the phone.
- Takes messages.
- Send pages.

It can also forward pages to other network nodes or inform callers of an alternate number where a subscriber can be reached...automatically.

MX-COM

Circle (248) on Fast Fact Card



Rack-Mount Power Supplies

A new line of rack-mount power supplies is available from **Newmar**. These heavy-duty supplies offer a high continuous duty output for powering amplifiers and high-power radios in base station, microwave and repeater sites. Outputs of 12V, 24V and 48V are available. For more information, contact P.O. Box 1306, Newport Beach, CA 92663; 714-751-0488.

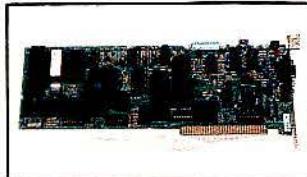
Circle (240) on Fast Fact Card



Quality Leather Cases

Bee Electronics uses only full grain leather and top-quality hardware. Bee has more than 300 models in stock including cases to fit the GE-TPX, Uniden SPU and SPH and the Motorola P100 and P200. All are available with a "quick draw" full metal swivel. 800-336-3115.

Circle (341) on Fast Fact Card



PacComm Wireless PC Modem

The IPC-320 Intelligent PC Communication Card allows data transfer through any radio. Appears to be an external Hayes compatible modem to communications software. Supports electronic mail forwarding, wireless data collection. External power jack to allow operation when PC is off.

PacComm Wireless Data Systems

813-275-6417; Fax: 813-872-8696

Circle (249) on Fast Fact Card



Communication Programmer

The EZ-writer multiprogrammer is a complete stand-alone EEPROM programmer. Optional NAMCel module converts the EZ-writer into a cellular telephone NAM programmer. The EZ-writer easily is expanded to support future communications programming technologies. Prices from \$795. **Bytek**: 800-523-1565.

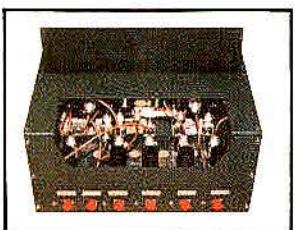
Circle (275) on Fast Fact Card



Three New Features for FM/AM-1200S

IFR Systems has unveiled its most complete communications service monitor ever. Now available are *Cellular* for testing cellular mobiles and portables; *Trunking* for testing Clearchannel LTR-compatible mobiles, portables and repeaters; and an internal *Tracking Generator* for observing frequency response of duplexers, filters and cavities.

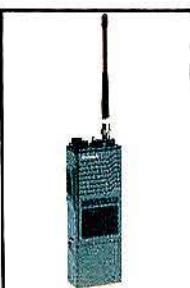
Circle (331) on Fast Fact Card



Sinclair Transmitter Combiner for 'Upband' Trunking Systems

The units operate at 150W continuous power and are available in 5-, 10- or 20-channel systems. There is a frequency separation of 0.0 to 10.0 with a frequency range of 935MHz to 940MHz.

Circle (260) on Fast Fact Card



Shinwa 'GX' Series Portable Radios

All solid state design and SMD circuitry to ensure the highest in performance and reliability. The "GX" series portable features crystal-controlled operation with six-channel capability. All controls are easily accessible on top of the radio. L.E.D. indicators for transmit, busy channel and low battery.

Circle (237) on Fast Fact Card

Product Preview



Malibu Antenna Site Expanded

Meridian Communications' Saddle Peak antenna site offers:

- 150-foot tower.
- Air-conditioned 1,200-square-foot block building.
- Standby power.
- State-of-the-art electrical grounding.
- The reliability required by such tenants as the L.A. County Sheriff's Department and the Southern California Gas Company.

Call 818-888-7000.

Circle (285) on Fast Fact Card



Maxi-II MF to DTMF Adapter

The **Hark** Maxi-II MF to DTMF adapter begins as a 19-inch rack-mount card cage holding eight DID trunk boards, one for each DID trunk to be interfaced. Each plug-in card contains a microprocessor-controlled circuit that automatically translates the MF signaling to a DTMF equivalent for the receiving equipment. Units stack to expand DID inputs.

Circle (283) on Fast Fact Card



FM-110 Communications Service Monitor

The FM-110 is a low-cost service monitor offering the same high quality and reliability of products manufactured by **AIE Measurements**. It is a compact instrument incorporating all functions needed by two-way radio shops for routine service to 512MHz. Only \$1,685.

Circle (290) on Fast Fact Card



SMC Electro-Mount

- Designers and manufacturers of quality mount hardware.
- Mounts are all we do. Customs welcome!
- OEMs, distributors and dealers are welcome.
- Manufacturers representatives are nationwide for your convenience.
- Private Texas corporation.

800-527-1079.

Fax: 713-351-0718.

Tomball, TX

Circle (284) on Fast Fact Card



Analog Microwave Radio

The series 8000 radio is a "light-route" radio systems suitable for private common-carrier and U.S. government applications. This radio includes telephone, radio or data channels via single- or multihop, line-of-sight links and a wide variety of TX power and RX thresholds. Radio Frequency operation includes 952MHz-960MHz, 1.710MHz-1.990MHz, 2.110MHz-2.200MHz and the 2.450MHz-2.500MHz bands.

ISC Cardion Electronics

Circle (272) on Fast Fact Card

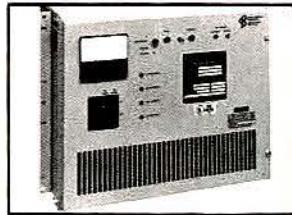


HX340 Series Synthesized Portable

Standard Communications' newest portable, available in UHF and VHF frequencies, features:

- Eight channels (16 TX using simplex/duplex switch).
- Wideband operation.
- Field-programmable and cloneable.
- Mil-Std 810D rated.
- Rated intrinsically safe.
- Periodic sleep mode for extended battery life.
- Wide range of accessories.

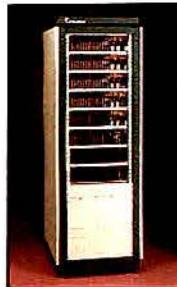
Circle (231) on Fast Fact Card



Downsized Battery Charger and Eliminator

The HFE-48-50B from **Power Conversion Products** delivers regulated, precisely controlled, filtered dc power for telecommunications equipment. Features local monitoring of output voltage and power, high and low dc voltage and low-output current alarm conditions, plus remote alarm monitoring. 815-459-9100.

Circle (274) on Fast Fact Card



Unipage System 160

The latest addition to the **Unipage** family of paging terminals is the System 160. This high-capacity paging terminal supports as many as 128,000 subscribers, 108 trunks, eight channels, 32 voice stores and 12 alpha ports.

Circle (278) on Fast Fact Card



Headset Catalog

A catalog is available from **Television Equipment Associates** describing some interesting and unique designs of headsets for use in broadcasting, intercom and two-way radio. Included in the catalog are the Neckset, a throat mic/speaker combination, the Secrette which actually straps onto your head, and the Slimgard, a lightweight noise protecting headset. T.E.A., Box 393, South Salem, NY 10590. 914-763-8893.

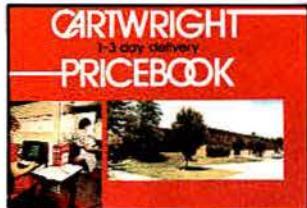
Circle (294) on Fast Fact Card



Model 3004 Mobile Display Decoder

Model 3004 decoder from **Bramco** offers an affordable option to larger more sophisticated units. It operates on 12Vdc and provides a one to four digit, backlit LCD display. The unit is programmable for input range, number of digits (up to four), timing, beeper, alarm and digit counting. It may be used as a desktop unit with separate wall-mount power pack.

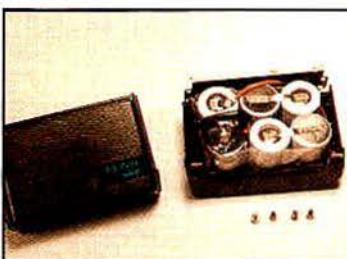
Circle (293) on Fast Fact Card



Cartwright Catalog

Get your free copy of **Cartwright's** latest price catalog. We stock Antenna Specialist, Celwave, Decibel Products, Andrew and Cablewave cable, Bird, Astron, SSC, Selectone, Federal Signal, Alexander, Multiplier and many other fine lines.

Circle (296) on Fast Fact Card



ICOM Batteries

New! **NCE** now offers battery-pack inserts for the ICOM hand-held radio series. Either send your dead battery to our factory or do it yourself. Also available—new high-power ICOM models IC-7P (13.2V/850mAh) and IC-8P (9.6V/1,000mAh). Contact National Custom Enterprises, 612-890-1360.

Circle (291) on Fast Fact Card



CONVERT TO NEWMAR

NEWMAR offers an easy solution to voltage conversion problems. NEWMAR DC-DC Converters provide a well-regulated 12 Volt output from 24 Volt input for operation of two-way radios, stereos, electronics, etc. Seven different models with output ratings from 3 to 50 Amps are in stock for immediate delivery. The rugged anodized aluminum chassis with integral shock mounts provides easy application on commercial vehicles, heavy equipment, trucks, and buses.

Call 1-800-854-3906
for our complete
product catalog.

NEWMAR P.O. BOX 1306, NEWPORT BEACH, CA 92663 (714) 751-0488

Circle (84) on Fast Fact Card

Target 28,647* Sales Prospects... For as little as \$54!

Your classified ad, in **Cellular Business**, reaches 28,647* subscribers who are expertly qualified to:

- Fill your job openings
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- and more!

And, for only \$54 for 1-inch ad (frequency discounts available).
Call today: (303) 762-1249

Then, be prepared to cash-in on your investment every month with **Cellular Business** classifieds.

*Harvey Research
New York, NY 1988



Product Preview



C2000 Battery Analyzer and Rejuvenator

- Analyzes four batteries simultaneously.
- Features individual program setting for each battery.
- Doubles as efficient fast-charger.
- Rejuvenates weak batteries by unique recondition method.
- Verifies battery condition to support warranty claims.
- Extends battery life; reduces replacement costs.
- Assures a high level of confidence in rechargeable batteries.

Cadex Electronics
Circle (287) on Fast Fact Card



Mobile, Portable, European Convertible

From car to portable, the **Philips** FM9210 cellular telephone's modular packaging is rivaled by its six internal surface-mount technology modules. Repair fast and simple, if ever needed. Contact local dealer or phone 407-740-6655.

Circle (229) on Fast Fact Card

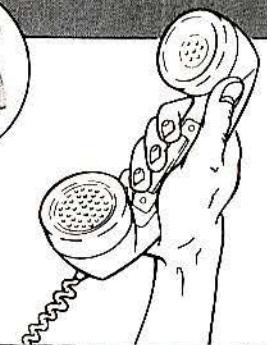


Helper's Toner III Solves Tone Problems

The Toner III counts and generates CTCSS and "beep" tones from 50Hz to 5,000Hz. The counter provides a resolution of 0.1Hz on tones up to 1,000Hz, and 1Hz above. Continuous tuning of the generated frequency permits testing decoders for proper bandwidth. **Helper Instruments**, 800-327-9308, 407-777-1440.

Circle (360) on Fast Fact Card

ON THE AIR...



Find out how easy it is to remote your two-way base station. Communications Products offers a complete line of DC, Tone, and Local Remotes

with a wide variety of housing styles. Signalling encoders and decoders and radio-telephone interconnect also available. Call for a free catalog.



COMMUNICATIONS PRODUCTS
13667 Floyd Circle • Dallas, TX 75243
(214) 238-9596 TELEX 203 941 ACTD-UR
(800) 527-4596 (outside of Texas)

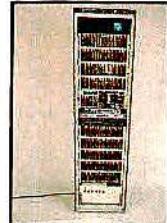
Circle (110) on Fast Fact Card



DTC Ear Mic

The new EM-1 ear mic from **Dynatech Tactical Communications** has increased intelligibility. Audio clarity is enhanced through the use of a unique dual-slope peaking circuit that amplifies and shapes the audio. The EM-1 ships ready to plug in and use. No batteries or radio modifications are required.

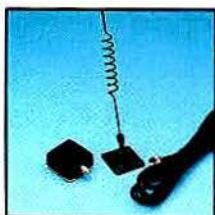
Circle (288) on Fast Fact Card



The Switch

The Switch by **Freeman Engineering** supports mobile, portable, point-to-multipoint, rural fixed radio and paging. It is a radio central office with a fully integrated switching system offering one to 30 channels, multiband operation, Follow Me feature, call queuing, timing, ticketing and initial subscriber capacity of 3,000, expandable to 48,000.

Circle (269) on Fast Fact Card



On-Glass II— 1 Millionth Cellular Antenna from A/S

On-Glass II (model APD852.3) features compact new coupler design, just $\frac{1}{8}$ " high, that fits between defroster grid wires, virtually eliminates defroster interference. Quick-removal whip connection is adjustable through 90° to achieve vertical position. No field tuning needed. High-tech black Dura-Coat finish.

Circle (308) on Fast Fact Card



New ME-400 from Data Signal

- full-size keypad in subminiature case
- backlit tactile-feel keypad
- continuous or precision-tone release
- safety timer releases hung PTT
- audible sidetone during dialing
- automatic microphone muting
- automatic PTT with TX delay
- transmit-ready light

800-652-9296
912-883-4703

Circle (340) on Fast Fact Card



Lexstar: The Longest-Lasting Batteries Available

Backed with a superior warranty, **Alexander** guarantees Lexstar batteries to hold at least 90% of stated capacity for a full year. Guaranteed not to short. Call for brochure, 800-247-1821 or 515-423-8955.

Circle (321) on Fast Fact Card

BE HEARD THROUGH THE NOISE.



When clear communication counts,

ADCO Industrial Intercoms break through the toughest problems—high ambient noise and harsh environments.

Because normal voice levels penetrate clearly, this is the perfect communication system for areas of high noise.

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Creating dependability since 1958, ADCO conquers noise.

Call or write for prices and complete information.

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A division of Guy F. Atkinson Company

Without a shout, without a doubt.

Circle (86) on Fast Fact Card

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Sweet's Cat. &
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One Billion Watts In Stock

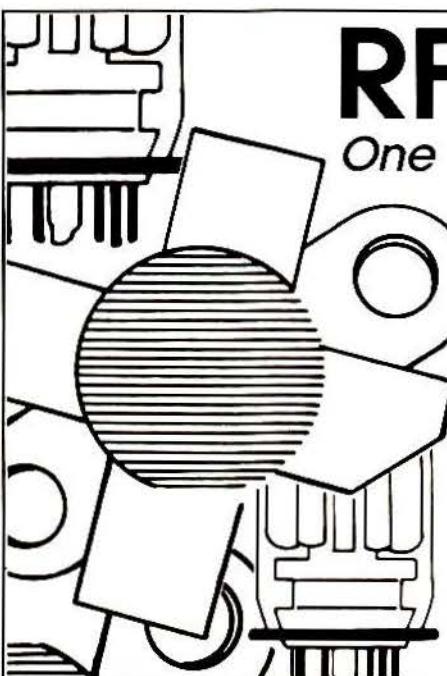
Make RF Gain your one stop source for RF Power Tubes and Transistors.

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Plus we ship 90% of all orders the same day they are received.

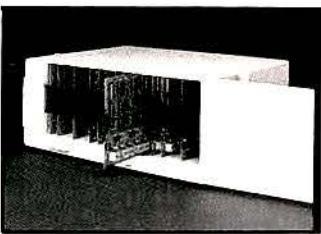
RF Gain, Ltd.

A Richardson Company
116 South Long Beach Road
Rockville Centre, NY 11570
516/536-8868; 800/645-2322
FAX: 516/872-4450
Corporate Headquarters:
312/208-2200; 800/323-1770



Circle (87) on Fast Fact Card

Product Preview



Low-Cost VF Switch

New compact, low-cost 376 series VF switch from **Raven Electronics** gives you large-system quality and features for the interconnection of mobile radio networks, microwave links and private and public telecom facilities. The system is a microprocessor-controlled, full-access, non-blocking crosspoint switching array with 16-line capacity expandable to 32 lines.

Circle (253) on Fast Fact Card



100-Channel Portable

Repcos 100-channel VHF portable, the SBX 159, breaks the VHF operating range into only two subbands: 132MHz to 150MHz and 148MHz to 175MHz. Standard features include 5W/1W switchable power, time-out timer, three scan modes, low-battery indicator and certification to MIL STD 810D. Options include an ANI/Scrambler/SOS module, DTMF keypad and 5-tone sequential signaling module.

Circle (233) on Fast Fact Card



Henry Radio Wireless Data Recorder

The ultra-small case contains a digital data receiver and miniature 40-column printer that's easy to connect to your two-way radio. It receives messages sent from your base station and stores them in memory; and prints them out when you get back to your vehicle.

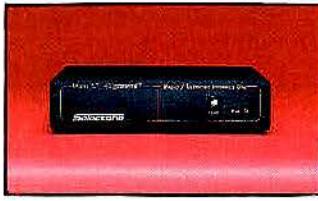
Circle (252) on Fast Fact Card



Yaesu Mobile Radios

The FTL-2001 VHF FM and the FTL-7002 UHF FM transceivers are designed to provide you with dependable communications. From their 12 channels that are expandable to 80, shock-resistant metal casing, priority and selectable scanning to their functionally designed controls, operation of the FTLs is quick and easy in any type of situation.

Circle (238) on Fast Fact Card



Radiotelephone Interface Unit

The ST-40 Hyperdyne radiotelephone interface unit from **Selectone** makes every office telephone a radio remote control. Easily connects any base station radio to any multiline office telephone system. Features VOX operated PTT with digital voice delay. Options for DTMF and two-tone paging and E. F. Johnson LTR remote control.

Circle (255) on Fast Fact Card



One-Stop Shopping For Your Complete Testing Needs

Primus Electronics is a nationwide distributor of radio communications equipment. Our stock of test equipment includes IFR service monitors; Telewave and Bird wattmeters; Goldstar oscilloscopes, multimeters and frequency counters; and the DB stand-alone cellular test box. For complete catalog or line card, call 800-435-1636; inside Illinois, 800-892-1413.

Circle (239) on Fast Fact Card

ADD WIRELESS DATA COMMUNICATIONS CAPABILITIES TO YOUR PRODUCTS

Contact PacComm for information on our full line of Packet Controllers and RF Equipment.

- Complete, low power units as small as 2" x 3"
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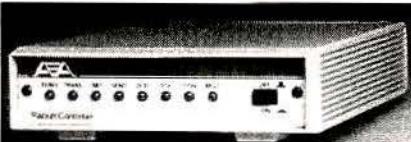
Circle (88) on Fast Fact Card



Paging Terminal

CTI introduces 1,000-call state-of-the-art small system paging terminal. Capabilities include two trunk input, liquid crystal display for 16 overlaid display digits, remote programming via DTMF telephone, analog and digital encoding, digital page storage, plus numerous other standard or optional features.

Circle (256) on Fast Fact Card



PK-90 Packet Radio Controller

Advanced Electronic Applications' PK-90 packet radio controller offers:

- Remote control of the PK-90 over the radio.
- Trunked radio interface for SMR use.
- Password access to critical commands.
- Macro key operation.
- Data encryption.
- Host computer control language.
- Optional internal modem.
- Extended temperature range option.

Circle (347) on Fast Fact Card



Antenna Support Structures and Reflectors

Microflex's new catalog lists tripods, monopoles, wall mounts and roof-mounted frames. Reflectors, which enable redirection of signals to circumvent natural and man-made obstacles that interfere with line-of-sight transmission, are included. Catalog and price lists are available free on request.

Circle (263) on Fast Fact Card



GE's Advanced S-825 Radio Control Unit

GE's new S-825 Mobile Radio Control Unit provides eight-character alphanumeric display; 432-channel capacity; large, color-coded function buttons; audio/visual feedback for each keypad function; dual-priority scan; Channel Guard select; and rugged all-weather housing. Call 800-GE-12345.

Circle (227) on Fast Fact Card



MICRO beep PAGING TERMINAL

2

How Microlink introduces the future to paging and mobile communications.

Ever since we began our company, we have always been about technology. At MICROLINK, our technology has completed an impressive record since 1977. For example, MICROLINK developed and became the world's first paging terminal that actually routes voice over a standard IBM PC AT or compatible computer. But, at MICROLINK, our engineers also understand that our products must meet a variety of user requirements, as well. We call them our "USER FRIENDLY" checklist. Every MICROLINK product must meet the 5 requirements our customers want most:

1. **FLEXIBILITY** - In today's business climate, MICROLINK paging and mobile communications products have to prove to customers their ability to lead to increased efficiency.

2. **GROW-ABILITY** - Our products must be able to grow with our customers. When one of our systems reaches its design limits, there's another system ready to take over. We even make it possible to hook up when the right time comes.

3. **PRICE-ABILITY** - Our users have to be able to meet the competition, be affordable and still give customers more product and flexibility for their money.

4. **RELIABILITY** - Naturally communications equipment must be a 24-hour day, 7 days per week environment.

5. **SERVICE-ABILITY** - As when lightning strikes, literally. Our 24-hour service line is ready to get you back running in the shortest time possible. Off-the-shelf replacement hardware is available for shipment on a 24-hour basis.

Shown below is another result of MICROLINK technology called **MICRO beep**, a single board paging terminal and security alarm system that plugs into any IBM PC XT AT or compatible personal computer. It can be operated from keyboard or telephone input, using PC-SIG formats (type, tally, numeric, or alphanumeric pages) designed for 250 subscribers. Optional one wall fully synthesized four frequency transmitter makes **MICRO beep** ideal for colleges, hotels, inns, small hospitals, restaurants, and any applications that need versatility and modest investment.

Let MICROLINK introduce you to advanced engineered products like **MICRO beep** today. Call Les McKenzie at (713) 488-6011. He'll introduce you to another outstanding feature of MICROLINK, our **MARKET-ABILITY**.



Circle (89) on Fast Fact Card

WACOM

LOW LOSS TRANSMITTER COMBINERS RECEIVER MULTICOUPERS

150-450-800 MHz

DUPLEXERS and CAVITY FILTERS, including our patented $B_p B_r$ CIRCUIT[®] FILTERS, for all bands within the frequency range of 30 to 960 MHz. Investigate this complete line of high performance products.

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Circle (90) on Fast Fact Card

Product Preview



Digital Link Receiver/Controller

The **Microlink** Link 72RC contains a single frequency crystal controlled dual conversion receiver and a digital based transmitter controller providing all necessary controls for a paging transmitter. The receiver features high selectivity through prefiltering. The controller features up to 256 individual addresses plus All-Call.

Circle (299) on Fast Fact Card

Full Duplex, 800MHz, Trunking Mobile Radio

Modeled after cellular telephones, The SMS 300TSD includes features such as:

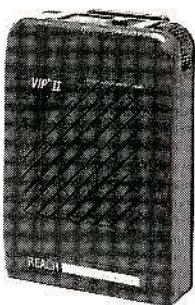
- 30 number memory.
- Hands-free operation.
- On-hook dialing.
- Electronic lock.
- Last number redial.
- System scan.
- Group scan.
- Mixed dispatch and interconnect.

Uniden Corporation of America

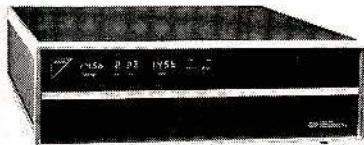
Circle (300) on Fast Fact Card

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The **LIAISON™** Terminal — Provides 2044 codes, up to 10 tone formats, digital, DTMF, voice storage, repeat message, and many more features. Call or write for specs.



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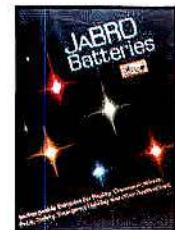
And get the finest in **PAGING TERMINALS** from **REACH** ... get the right one for the job.



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Circle (91) on Fast Fact Card

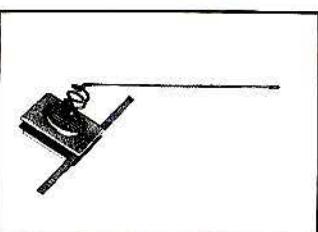


Rechargeable Replacement Batteries

A revised catalog featuring nickel-cadmium and sealed lead-acid batteries for two-way radios, pagers, emergency, and security lighting, and other applications is available. More than 200 batteries are listed, with many illustrated and cross-referenced to simplify ordering.

JaBro Batteries, Lisle, IL 60532.

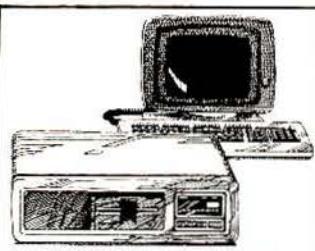
Circle (226) on Fast Fact Card



UHF Glass-Mount Antenna

Mobile Mark announces model OW3-450 Jr., patented, UHF glass-mounted antenna with 3dB gain. This antenna can go through a car wash without being removed or adjusted. The black chrome electroplated whip is only 20" long. Call 312-671-6690.

Circle (281) on Fast Fact Card



Computer Resources

Looking for answers to management information systems? The **Computer Resources**' Service Management System is a fully integrated system from accounting to inventory control, sales, service, SMR and pager billing. This system is available for Unix and Xenix operating systems.

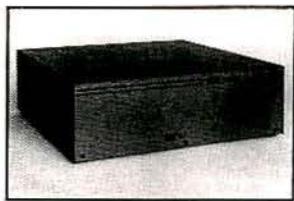
Circle (292) on Fast Fact Card



Marconi Instruments' Model 2957 Cellular Radio Test System

Model 2957 cellular radio test system provides RF/AF test facilities and the 10kbit AMPS data stream necessary for full cell-site simulation for a radio under test. The mobile/portable's performance is automatically verified via user-defined, menu-driven test sequences, and full test data is displayed.

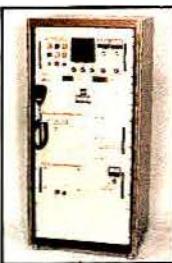
Circle (315) on Fast Fact Card



Blackhawk Network Box

The Network Box is a microprocessor product that decodes TNPP network paging traffic and encodes it into digital pages. It can work with any paging terminal and transmitter. It is a low-cost way to add a local, regional or national network to a paging system. Call 919-872-7296.

Circle (270) on Fast Fact Card



High-Power Repeaters

The **Spectrum Communications** SCR1000A and SCR4000A series of FM or FSK repeaters provides high performance and reliability in the 72MHz, 150MHz, 216MHz and 450MHz bands, at power levels from 10W to 150W. Features: panel metering, CW IDer, battery backup, optional tone panel, interconnect, link receivers and transmitters, duplexers and more.

Circle (280) on Fast Fact Card



Shure SmartAMP Mobile RF Amplifier

If adverse operating conditions threaten the SmartAMP, its unique protection circuitry automatically shuts itself down while keeping the user on air. When conditions permit safe operation, SmartAMP automatically resets. A warranty covers all components including the final RF power transistors. In Illinois, call 800-624-8522. Outside of Illinois, call 800-257-4873.

Circle (232) on Fast Fact Card



Advanced Radios from Regency Plus

Regency Land Mobile's new Plus radios represent advanced two-way radio technology available. Track-tuning, DCS, a reversible display, instant priority and a smart charging system are features in the Plus line. Quality, durability, affordability. Built in the United States. Regency Plus...radios to depend on.

Circle (254) on Fast Fact Card

THE WORLD'S LARGEST COLLECTION OF TELEPHONE INTER-CONNECTS AND "HOW TO" USE THEM!



FREE

Write or call today for "Your Personal Telephone Interconnect Planning Guide" — an informative booklet brimming with useful information on how to connect your radios to the public switched telephone network, system characteristics, types of interconnects, installation of interconnects, FCC licensing and more.

Make The RIGHT Connection

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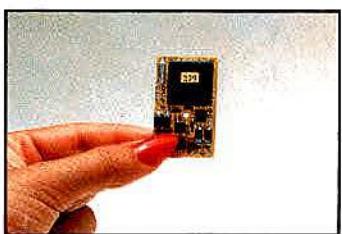
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Winter Park, Florida 32792 407-679-8110

Call us now,
TOLL FREE
1-800
327-9956

Circle (92) on Fast Fact Card

May 1989 *Mobile Radio Technology* 91

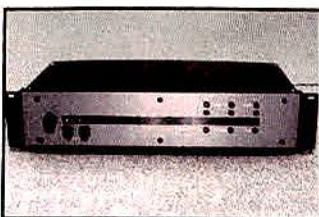
Product Preview



Digital ANI

The ID-33 is **Control Signal's** state-of-the-art, subminiature digital ANI board that identifies every transmission. Designed for portables and mobiles, it eliminates horseplay and stuck mikes. It includes a time-out timer, emergency and status messages and ANI. The error-corrected burst is a mere 100ms. Call 800-521-2203.

Circle (273) on Fast Fact Card



Community Repeater Interconnect

IDA model 40-60 full- and half-duplex community repeater interconnect supports 38 standard EIA CTCSS tones, CDCSS and/or ANI signaling for access and control of mobiles. Features include remote validation, one to eight phone lines, on-board tone panel and optional accounting memory with repeater statistics. 800-843-2197.

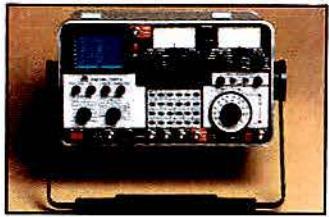
Circle (277) on Fast Fact Card



Call Accounting and Billing System

The **CES** 3500 Remote Data Station and 4040 billing software collects, stores and communicates call accounting data from CES shared system interconnects or E. F. Johnson LTR RICs to a centralized IBM computer system for telephone timed billing. For additional information, call 800-327-9956.

Circle (242) on Fast Fact Card



Top IFR Distributor

Communications Associates was recently awarded the 1988 Communications Distributor Performance Award by IFR Systems for sales of IFR test equipment in 1988. A large inventory is maintained of FM and AM 1200 service monitors, including monitors with cellular and trunking test options. Call 800-435-9313 or inside Illinois, call 800-892-1611.

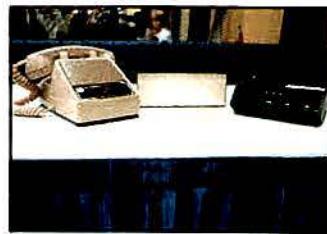
Circle (286) on Fast Fact Card



'Tuf Duck' Says...

Centurion provides the highest-quality molded antenna in the industry. We are a leading supplier to OEMs in various industry segments. Currently available with 11 connector styles, our EX series fits every EXTRA need.

Circle (328) on Fast Fact Card

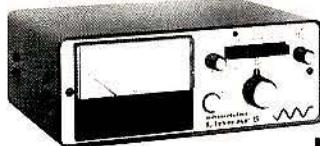


Remote Control for Trunked Radios

The new voice annunciated termination panel from **Communications Products** provides remote users a digitized voice message indicating system and group. Remote functions include PTT, scan and system or group select on most newer models of E. F. Johnson and Uniden radios. 800-527-4596 or 214-238-9596.

Circle (301) on Fast Fact Card

SL-105 SINADDER™ NOW—WITH AUDIO DISTORTION SCALE



True RMS SINAD & 8 range RMS Voltmeter

HELPER INSTRUMENTS COMPANY

407/777-1440

800/327-9308

FAX: 407/777-1447

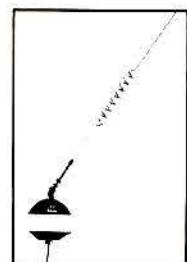
TELEX 362837 (HELPER UD)

P.O. BOX 3628

INDIALANTIC, FLORIDA 32903 USA

SL-105 \$395
CML-1 with C-message
filter for Cellular \$525

Circle (93) on Fast Fact Card



KG-825 Sports Sleek Look

The **Larsen** Kulglass KG-825 series glass-mount antenna is housed in a black polycarbonate coupler half the size of the previous model, resulting in a sleek appearance without sacrificing performance. The patented design allows the placement of the transformer outside the vehicle. Call 206-573-2722.

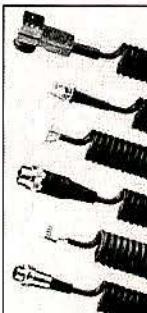
Circle (261) on Fast Fact Card

TALK OUT

SHURE MODULINK...THE FIRST MODULAR MOBILE CORDSET/MICROPHONE SYSTEM

Just 30 seconds—that's all it takes to get a mobile system up and operating if cord failure occurs. ModuLink System 1 from Shure makes it that fast, because microphone and cordset are *separate* modular units.

ModuLink System 1 is the first cost-effective mobile microphone/cordset system designed to reduce your inventory and improve your service efficiency. Now you can simply stock cordsets and a single line of microphones for all the radios you use and service.

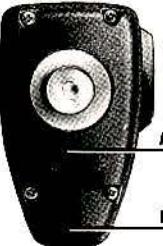


ERGONOMIC DESIGN.

ModuLink microphones feature Top-Talk Sound Channels™ which end muffled voice input if the user grips the mic from the front.

SET LEVELS FAST.

Now, adjust audio without opening the mic or the radio. Level is easily set through external access port (A). Cordset can be quickly released from mic via access port (B).



For more information about MODULINK SYSTEM 1, call toll-free **1-800-257-4873** (in Illinois, call 1-800-624-8522). Or fill out and mail coupon below.

SHURE BROTHERS INC.
Communications Products, Dept. 1511
222 Hartley Avenue, Evanston, IL 60202-3696

YES, please tell me more about ModuLink System 1.

Name

Title

Company

Address

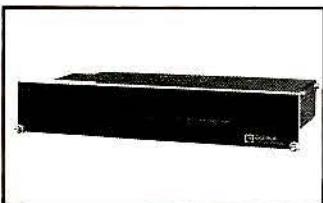
City State Zip

Phone AREA CODE

MR059M

SHURE
MODULINK

Circle (94) on Fast Fact Card



SimulComm Control System

Quintron's SimulComm Control System provides automatic control and monitoring of simulcast paging and two-way systems that use either wireline or radiolink distribution. It incorporates an automatic transmitter frequency control and locking scheme to maintain peak system performance without the need for frequent site visits.

Circle (279) on Fast Fact Card



Cushcraft Antennas

Cushcraft/Signals base station line features antennas for every application. Heavy-duty repeater antennas, control station antennas, economy omnis and special antennas for point-to-point use are all included. For a 1989 catalog, call Cushcraft/Signals, 800-258-3860.

Circle (297) on Fast Fact Card



Hand-held Programmer for IC-110

Designed for field programming of **Communications Specialists** IC-110 tone signaling microcircuit, the hand-held programmer allows technicians to change tone memory to provide non-standard DIP switch tones, plus allows other special applications: operates on 9V battery (provided); small size for easy portability; one-year warranty; price: \$199.95.

Circle (289) on Fast Fact Card



BBL Industries

The MVP is expandable from four to 128 ports, 22 to 528 hours of storage and supports as many as 25,000 subscribers. The combined strength of its redundant capabilities, multiple trunk interfaces, distributed functions, plug-in modules and automatic database backup make the MVP specifically designed to handle public access markets.

Circle (282) on Fast Fact Card



Page-Com

The P10 series is two-way radio designed for durability. This lightweight one watt, one channel crystal controlled portable includes desktop charger, flexible antennas, belt clip and nicad battery pack. Call 800-527-1670, in Texas call collect, 214-680-9750.

Circle (298) on Fast Fact Card

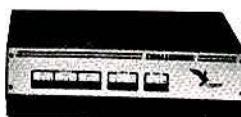


Schlumberger's Stabilock 4031

Schlumberger's 25 years of experience in radio test has produced the Stabilock 4031 communication test set. It has all the devices for radio testing integrated into a small, portable package. Whether in the shop, on the road or up a tower, count on the 4031.

Circle (268) on Fast Fact Card

Blackhawk — Best Value in Paging Terminals



Challenger ST Model STANDARD Features

- ★ 1000 Capacity
- ★ All Tone & Digital Formats
- ★ Voice Storage (2 Solid State Recorders with "Silence Compression")
- ★ 2 Trunks
- ★ CRT Included
- ★ Billings & Traffic Data

\$4795

Challenger XT Model STANDARD Features

- ★ 1000/2000 Capacity
- ★ All Tone & Digital Formats
- ★ Voice Storage (4 Solid State Recorders with "Silence Compression")
- ★ 4 Trunks
- ★ CRT Included
- ★ Billings & Traffic Data

\$7495



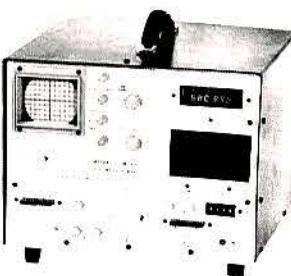
For More Information and FAST Service Please Contact:

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RALEIGH, NC 27604 (919)850-0165 (Factory)

Circle (95) on Fast Fact Card

SERVICE MONITOR MEASUREMENTS MODEL FM 110

- Covers all business channels from 30MHz to 512MHz
- Monitor: 2uV, frequency error display, scope deviation display
- Generator: Calibrated output up to 10mV, Sinad display
- Built-in Tone Generators



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Circle (96) on Fast Fact Card

PacComm WIRELESS MODEM

- Ideal for mobile dispatch, industrial telemetry, dedicated landline replacement
- Advanced technology in a high quality, reliable design
- Error eliminating protocol, data scrambling for privacy
- Available with or without embedded RF Transceiver
- Medium and High Data Transfer Rates supported
- Many unique and useful features

PacComm WIRELESS DATA SYSTEMS, INC.

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Circle (97) on Fast Fact Card

New products

SWR measurement kit
works with service monitors



The operating range of the Swersweep SWR measurement kit has been extended to cover 1MHz to 1,000MHz. The kit works with service monitors that have a tracking generator and spectrum analyzer, such as the IFR 1200S. Offered by Europa Marketing, the kit allows a service monitor to display a plot of SWR vs. frequency on the CRT to allow quick, accurate tuning of antennas, duplexers, isolators, combiners and receiver front ends. Each Swersweep has calibration traceable to the National Institute of Standards and Technology (formerly the National Bureau of Standards).

Circle (426) on Fast Fact Card

Interconnect suits base,
mobile applications



Programming for the ACI-35 audio controlled interconnect can be changed remotely from any DTMF telephone. The CES unit suits single frequency base and mobile applications and can be used as a control station interface.

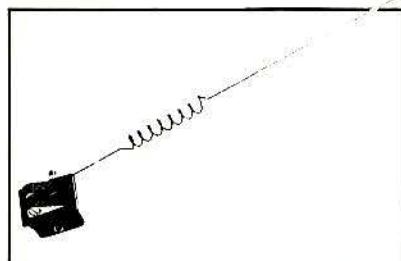
Circle (401) on Fast Fact Card

Readers' choice

Of all the new products and services covered in the September 1988 issue of *MRT*, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact number on the Fast Fact Card found in the back of this issue and mail the card to us.

Glass-mount antennas cover VHF highband channels

Two VHF antennas from Antenna Specialists resemble the company's glass-mount cellular antennas. Model AP-143 covers 138MHz to 150MHz, and model AP-153 covers 150MHz to 174MHz. The glass-mount disguise antennas have a power rating of 100W continuous, 150W intermittent. The self-resonant halfwave design requires no ground plane, and the antennas install in minutes without drilling.



Circle (215) on Fast Fact Card

Lightning-surge arrestors use gas-filled discharge element

antenna line and use a gas-filled discharge element. A secondary stage provides protection to equipment. The units restore themselves and divert unwanted surges away from equipment to a safe ground. The arrestors are rated up to 2,000W for transmitters and are available with UHF, BNC and N connectors.

Circle (214) on Fast Fact Card

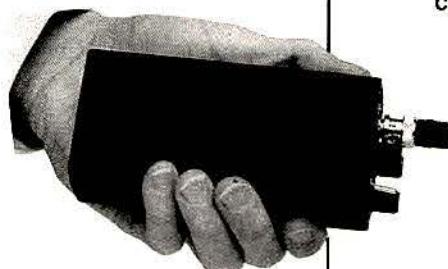


Lightning-surge arrestors from SpiRo Manufacturing install in the

Hand-held offers built-in voice scrambling module

Advanced Videotech's 5W, four-channel hand-held, two-way radio, Tech Talk, features a built-in voice scrambling module.

Circle (216) on Fast Fact Card



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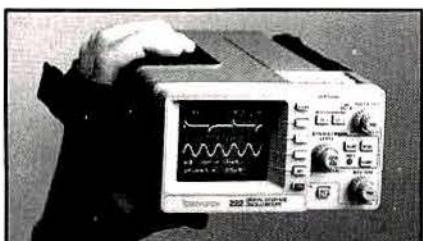
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Circle (98) on Fast Fact Card

New products

Hand-held storage scope features dual channels



The Tek 222 digital storage oscilloscope from **Tektronix** offers dual-channel, 10MHz performance with features such as automatic test setup and digital save and recall of front-panel settings and captured waveforms.

Circle (217) on Fast Fact Card

Radios offer scan, 100-channel memory

Tait Electronics' T700 radios incorporate push-button channel select with priority setting, scan and 100-channel memory. The radios can be programmed to meet individual needs via a personal computer within minutes. Options the radio can accommodate include a scrambler, DTMF dialing and selective calling capability.

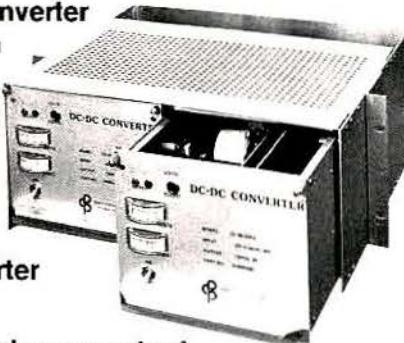
Circle (468) on Fast Fact Card

PCP MAXIMIZES Cell Site Power



PCP's dependable, efficient and quiet DC to DC Converters offer a wide range of isolated outputs from a single battery source. The converter's 50 KHz technology provides high efficiency, excellent regulating characteristics, superior transient response, and clean, quiet operation.

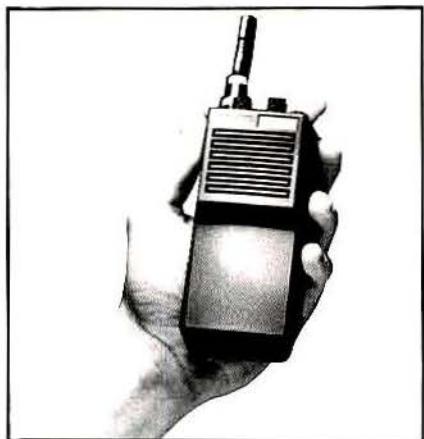
The compact, lightweight converter system includes dual plug-in modules for redundant operation and easy installation into the 7" H x 19" W x 14.1" D mounting shelf (occupies only 4 vertical rack spaces). Total weight of a dual converter system is 27 lbs.



Each converter module includes: an output voltmeter and ammeter, front-access test jacks, adjustable output voltage, input circuit breaker, isolation diode, load sharing, high voltage shutdown, and form "C" contacts for remote indication of high or low voltage conditions. Popular models also include automatic restart.

Call us today for complete product information on PCP's DC to DC Converters.

Portable operation extends as far as 6 miles



Instant local communications at ranges as far as 6 miles is available with **Trycomm's TR-105** miniature transceiver. The portable unit carries both voice and data messages and covers the 150MHz to 174MHz band. The 6W unit comes with a 450mAh rechargeable battery, ac charger-adapter, flexible rubber antenna, stainless steel belt clip, protective case and a fast-slow rate drop charger.

Circle (411) on Fast Fact Card

Voice recording unit comes in 1-, 2-channel versions

An instant recall, voice recording unit from **J.E.I.** is available in one- and two-channel configurations. The unit offers simultaneous record and playback, and a "mark" button allows any portion of a conversation to be marked for instant recall. The recorder is available with storage times from 3 1/2 minutes to 22 minutes.

Circle (302) on Fast Fact Card



power conversion products inc.

forty two east street p o box 380
crystal lake, illinois 60014
phone 815/459-9100 fax 910/634-3356
fax 815/459-9118

Circle (107) on Fast Fact Card

Quarterly report details cellular subscribers

Herschel Shosteck Associates' quarterly analysis of the cellular industry, "Cellular Subscribers and Forecasts," describes past, present and future cellular trends. The report identifies factors affecting the cellular industry and predicts the future marketplace through 1990.

Circle (266) on Fast Fact Card

Catalog provides cable types, uses

Planning information for land mobile radio feeder systems is included in a catalog from **Andrew**. A guide lists recommended cable types by frequency and length. The guide is supplemented by selection process information and attenuation and power ratings. Connectors, accessories for installation, jumper cables and pressurization equipment are listed.

Circle (267) on Fast Fact Card

Bulletin outlines coaxial cable specs

Technical bulletin No. 138A from **Cablewave Systems** outlines electrical specifications for coaxial cable such as maximum operating frequency, impedance, velocity of propagation, attenuation and dc resistance. Mechanical specifications covered include nominal size, outer and center conductor jacket material, maximum pulling force and minimum bending radius.

Circle (265) on Fast Fact Card

Data sheet focuses on waveguide measurements

Wiltron's waveguide measurement data sheet details waveguide applications and distinctions between waveguide and coax. Special requirements associated with making waveguide measurements and how model 360 vector network analyzer can handle those requirements are discussed.

Circle (258) on Fast Fact Card

Catalog lists tools, kits

Expanded tool kit and hand tool product lines are displayed in a catalog from **Hand Tool Industries**. More than 20 tool kits with more than 80 case selections are featured. Standard and hard-to-find hand tools; time and labor saving tool kits; hand tools; test equipment; production aids; and related products for telecommunications service are included.

Circle (259) on Fast Fact Card

Catalog features 900 test products

Descriptions and illustrations of 900 test products are found in the **Pomona Electronics** catalog. In addition to existing lines, the catalog features new static control products, oscilloscope probe kits, multimeter test lead adapter kits, test probe kits, test clip kits, and IC, SMD, and VLSI test products.

Circle (262) on Fast Fact Card

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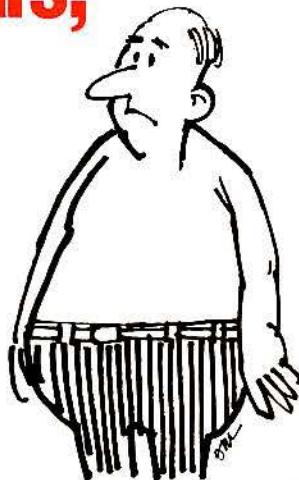
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Circle (100) on Fast Fact Card

Private carrier paging market tagged 'good'

The private carrier paging marketplace continues to garner widespread interest, according to results of the October 1988 "What Do You Think?" questionnaire on the subject. The majority of the readers view the opportunities as average and good, with some perceiving the market as excellent as reported in these statistics:

PCP MARKETPLACE OUTLOOK	%
Excellent	13.6%
Good	40.9%
Average	40.9%
Below average	4.6%
Poor	0%

Readers credit various factors for the progression of the marketplace, namely the relatively deregulated environment surrounding entry, which is an advantage over common carrier applications. Private carrier licensing takes approximately 60 days, from beginning to

end, and applications are rarely contested because most frequencies are shared. Private radio applications are not placed on public notice, which makes it difficult for other interested parties to file petitions to deny licensing.

Besides deregulation, respondents perceive opportunity as generating the market's growth. "It opened up new territory for some businesses and dealers," says a dealer. "There is a realization of potential by new and old pager people," echoes a private carrier paging reseller.

Advantages of the private carrier paging market include low costs, ease of getting a license, additional revenue, unlimited potential with nationwide networking, no state intervention, quick startup, and it is an untapped market, according to respondents.

Disadvantages of doing business as a private carrier include shared frequencies, heavy competition, unregulated channel use, too many licenses in some areas, capital-intensive operation and

competition from larger RCCs, readers report.

"Co-channel sharing almost precludes wide-area systems," comments a vice president of an RCC consulting firm. "Interference and non-exclusive frequencies" are other disadvantages, comments a controller employed by a licensed private carrier paging operation. "RCC millionaires are getting the private carrier paging frequencies all tied up," adds a dealer.

Private carrier paging has half as many frequencies to choose from compared to the common carrier service, and readers believe the market will be viable until it becomes saturated. "It will be attractive until channels become crowded in localized areas," comments a reader. "It is limited in face of full-service carriers," adds a reader. "There will be heavy growth the next couple of years, then a leveling off," suggests a private carrier licensee. 

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Circle (101) on Fast Fact Card



Lemons



Hodgson



Chambers



Leffler

Steve Lemons, vice president of sales and marketing for Celltronics, San Diego, advances to president and will serve on the board. **Joe Banos**, one of the company's founders, resigns as president but remains a consultant and board member.

Ryan Hodgson, technical services manager for Midland LMR, Kansas City, MO, advances to customer sales department manager.

Sylvia Chambers moves from area systems engineer with Motorola, Schaumburg, IL, to Antenna Specialists, Cleveland, as major account manager.

Alan Leffler resigns as district manager for Schaumburg.

IL-based Motorola Communications and Electronics to join Celwave, Marlboro, NJ, as regional manager based in Cedar City, UT.

Changes at Associated Public Safety Communications Officers (APCO), New Smyrna Beach, FL:

A reorganization follows the retirement of **Charles F. English** as director of the frequency coordination department. During the reorganization period, **Alireza Shahnami** served as acting director. The director's post since has been discontinued; Shahnami becomes the department's manager.

Don R. Precure, P.E., retires as an engineer with the FCC Office of Engineering and Technology to become APCO's director of technical service. In the new post, Precure will oversee the frequency coordination department.

Changes at Dynatel Radio Access, Pasadena, CA: **Dave Shaw**, general manager of operations, becomes president, replacing **Will Shaw**, who will serve as a consultant to company management. **Bob Osmers** departs as a sales representative with General Electric in New York to join Dynatel as manager of sales. **Mike Thilgen** leaves as service manager with Pacific Comm, Santa Monica, CA, to become Dynatel manager of engineering. **Bill Moore** exits E. F. Johnson, Waseca, MN, as account executive to become Dynatel major accounts specialists.



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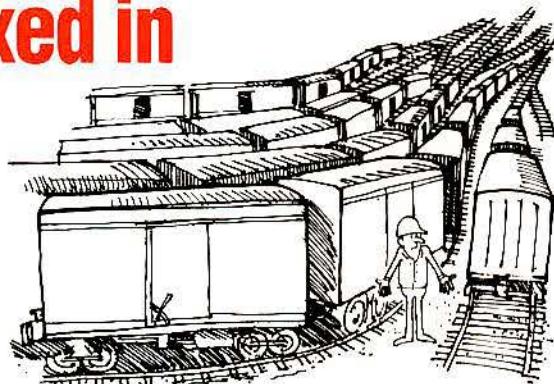
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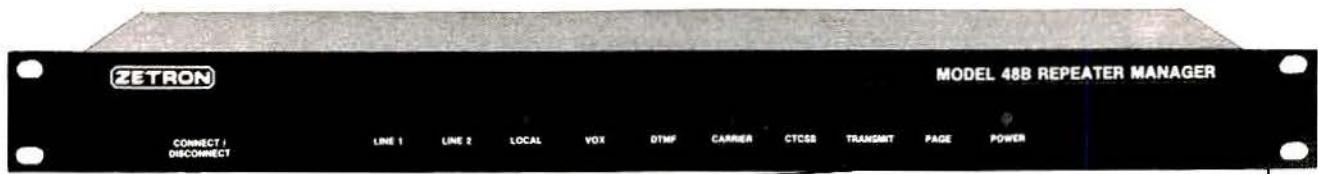
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Circle (103) on Fast Fact Card

May 1989 *Mobile Radio Technology* 99

Circle (102) on Fast Fact Card

MODEL 48-B



Dear Zetron:

Question:

Since Zetron manufactures REPEATER TONE PANELS that have a built in PHONE PATCH, when does it make sense to allow telephone interconnect on a community repeater system?

Answer:

If your goal is like that of most community repeater operators, then you want to MAXIMIZE REVENUE by having your systems fully loaded. However, this can be difficult in areas with a small customer base or where there is fierce competition. In these situations, adding phone patch capability is a good way to increase the number of customers and system revenue.

Question:

If it makes sense to add a phone patch to my community repeater, what's the best way to do it?

Answer:

Buy a system that's INTEGRATED, where both the phone patch and the repeater tone panel are in one. You can do important things this way that you can't do if you try using separate panels and phone patches. For example, you can use each mobile's CTCSS or Digital Squelch as the ANI sequence to SIMPLIFY USER OPERATION. This also means that only authorized mobiles have access to the phone patch. Another big plus is FREEDOM FROM CO-CHANNEL INTERFERENCE which results from the Model 48B being able to lock onto only one user for the duration of each conversation. CLEAN INSTALLATION is another major benefit: one nice package vs. haywiring two separate boxes from different vendors with no documentation to back you up when you need it most.

Question:

With an integrated unit like the Zetron Model 48B Repeater Manager, do I lose any capabilities?

Answer:

No, you get more capability than any other way. The Model 48B Repeater Manager delivers both a full featured phone patch and a full featured repeater panel in one package. Phone patch capabilities include multiple phone line inputs, selective calling formats, ANI capabilities, remote programming and billing information. The repeater panel delivers high performance ToneLock CTCSS and DCS encode/decode along with Morse Code ID, air-time billing, and remote programming capability.

Model 48B Repeater Manager

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- High Performance ToneLock CTCSS and DCS Decode
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- Remote Programming and Billing Information Retrieval

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May

1-3—Vehicle Technology Conference, sponsored by IEEE Vehicular Technology Society, Sir Francis Drake Hotel, San Francisco. Contact: Frank Thatcher, 415-956-6118.

3-5—Telocator Spring International Convention, Orange County Convention Center/Civic Center, Orlando, FL. Contact: 202-467-4781.

21-25—Associated Public-Safety Communications Officers East Coast Regional Conference, Marriott Hotel, Charleston, WV. Contact: 304-768-3732.

June

18-21—Utilities Telecommunications Council Annual Meeting, Lake Buena Vista Palace, Orlando, FL. Contact: 301-621-5596.

21-23—Associated Public-Safety Communications Officers Northwest Training Conference and Trade Show, West Coast Wenatchee Center Hotel and Convention Center, Wenatchee, WA. Contact: Pam Ratcliffe, 206-774-3583.

22-23—American SMR Network Association Annual

Meeting, The Capital Hilton, Washington, DC. Contact: 202-331-7773.

July

17-19—Forestry-Conservation Communications Association, Coeur D'Alene, ID. Contact: 208-765-1811.

August

6-10—Associated Public-Safety Communications Officers 55th Annual National Conference, John Ascuaga's Nugget, Sparks, NV. Contact: 800-824-1850.

27-30—International Association of Fire Chiefs Annual Meeting, Indianapolis Convention Center, Indianapolis. Contact: 202-833-3420.

September

7-9—Land Mobile Expo/East, Orange County Convention Center/Civic Center, Orlando, FL. Contact: 303-220-0600.

28-30—Special Industrial Radio Service Association Annual Meeting, Lake Tahoe Hyatt, Lake Tahoe, NV. Contact: 703-528-5115.



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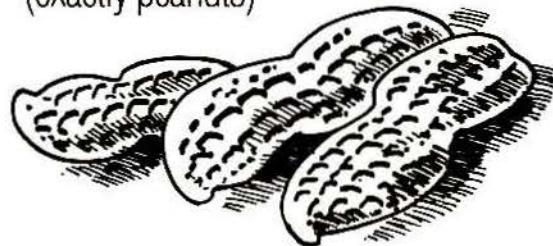
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C classified

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Ads larger than one inch are sized in $\frac{1}{4}$ -inch increments and billed accordingly, as determined by total size of the ad, including ruled borders and rounded up to the nearest $\frac{1}{4}$ -inch.

Bind box ads (replies sent to **MRT** for forwarding) are \$30.00 and Fast Fact reader service numbers are available for \$25.00 per service, per insertion, to cover processing and handling costs.

Optional color, determined by **MRT** on an issue-by-issue basis, is available at \$150 per insertion.

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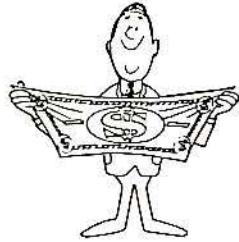
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1 Mot Mocom 10 Base 30-36MHz 25 watt PL \$100
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6 GE EX I Base VHF, UHF, 28-33MHz 50 watt \$150
5 Mot Mitrek UHF 100 watt PL/DPL \$595
12 MOT MICORS UHF 100W 12 Freq. W/S PL \$395
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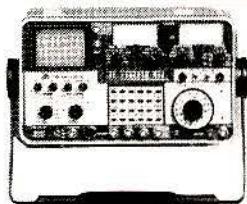
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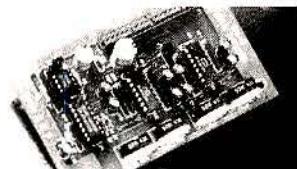


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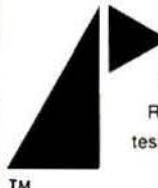
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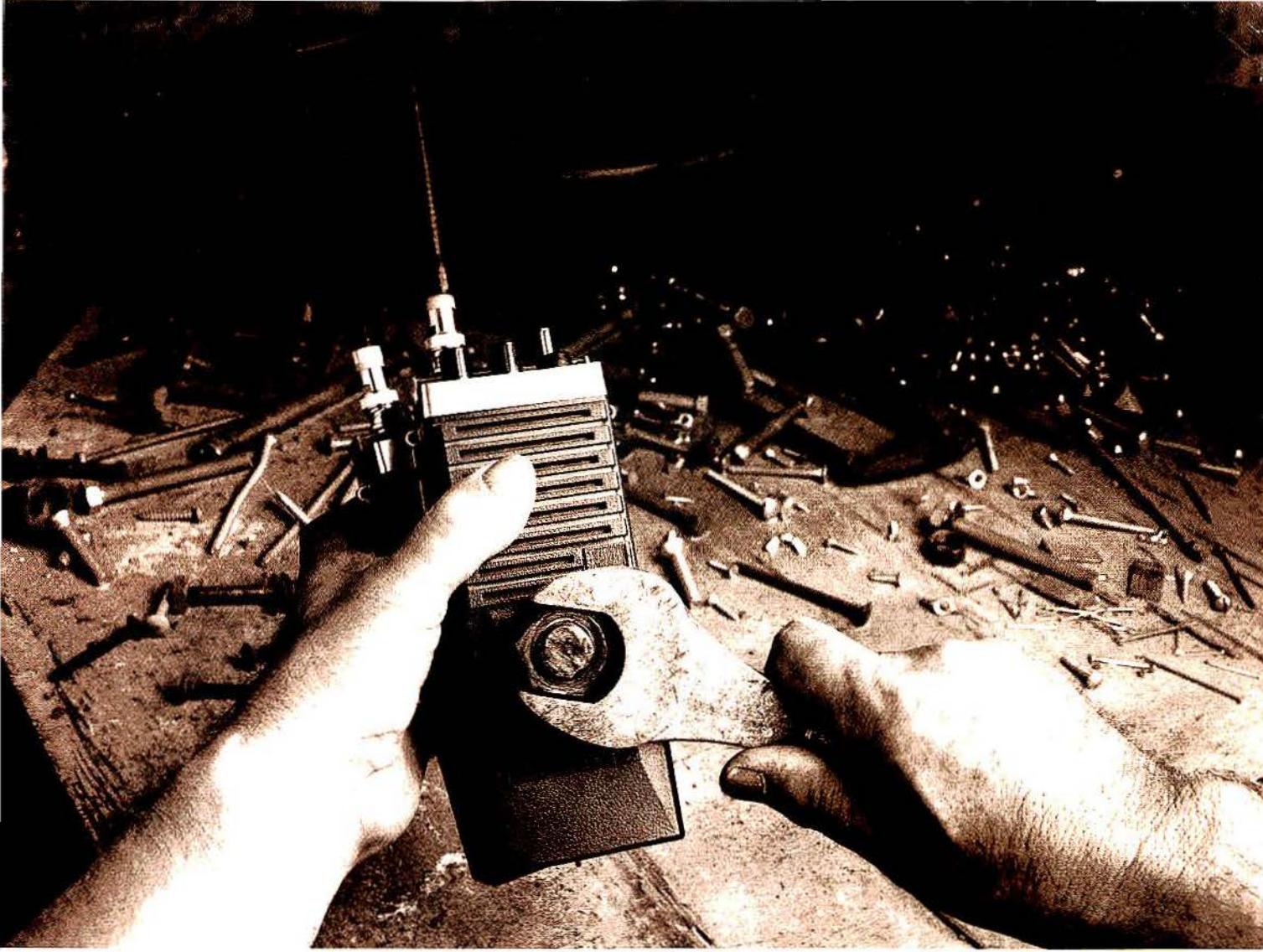
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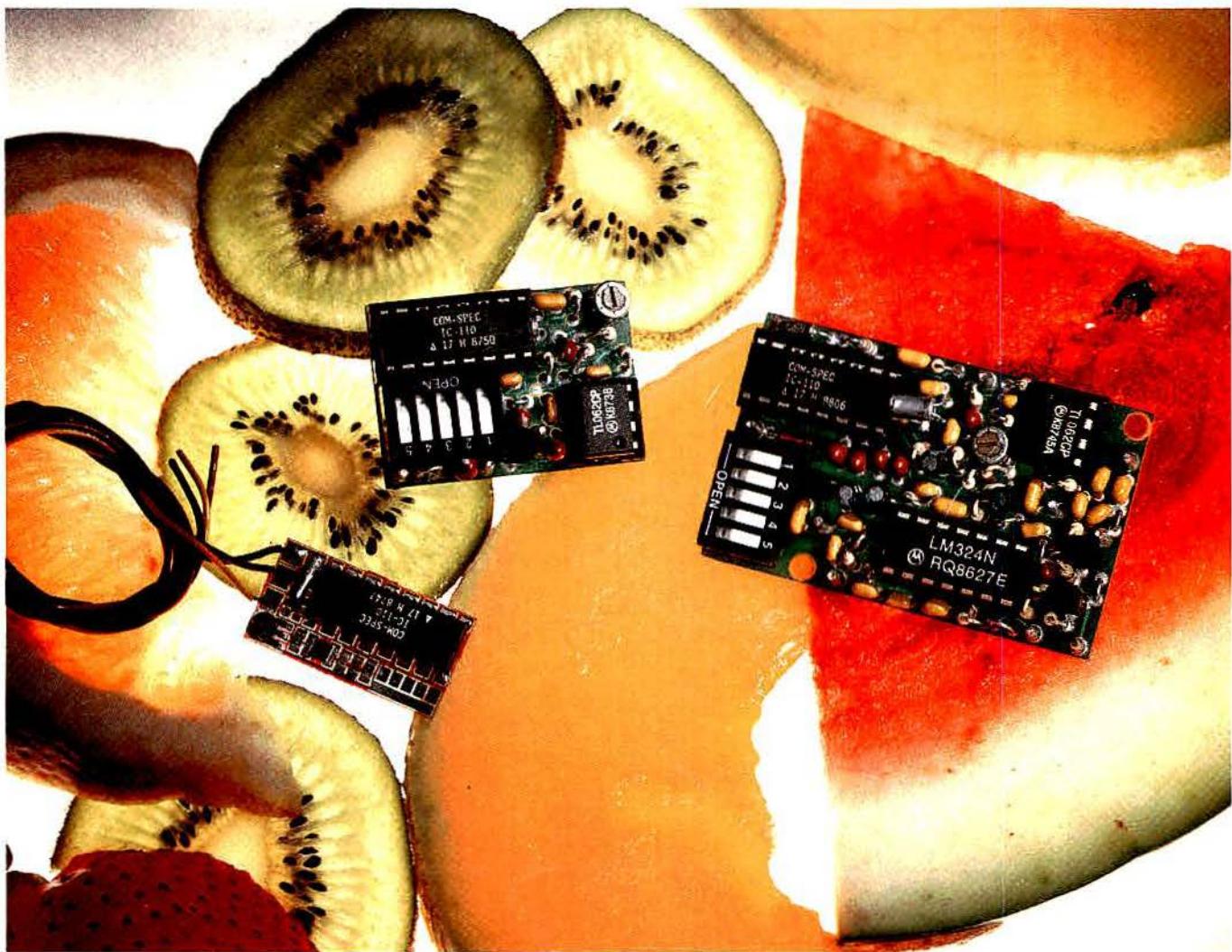
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